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OF THE

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No. 48

OPERATIONS AT RIVER STATIONS, 1900.—PART II

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1900

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART II

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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OPERATIONS AT RIVER STATIONS, 1900.

PART II.

MEASUREMENTS AT RIVER STATIONS.[1]

WISSAHICKON CREEK NEAR PHILADELPHIA, PENNSYLVANIA.

This station is described in the Twentieth Annual Report, Part IV, page 94, followed by tables of monthly flow for 1897 and 1898. In Water-Supply Paper No. 35, page 74, will be found the figures for the daily discharge for 1899, ending with June 5, when the observations were discontinued temporarily, and were not again resumed until July 1, 1900. The figures for monthly flow for 1899 and diagrams of daily discharge for the entire period of observation (1897 to 1899, inclusive) will be found in the Twenty-first Annual Report, Part IV, pages 81 and 82. The following tables contain the figures for the daily discharge from which the diagrams were constructed, as well as those for 1900, diagram for which is not yet plotted.

Daily discharge, in second-feet, of Wissahickon Creek near Philadelphia, Pennsylvania, for 1897.

[Drainage area, 64.6 square miles.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	84	62	162	76	41	68	65
2	.....	87	72	148	102	25	432	65
3	.....	74	63	139	74	24	132	65
4	.....	137	60	131	55	29	77	74
5	91	168	56	134	59	32	65	276
6	83	117	56	128	67	30	46	136
7	75	75	53	120	67	29	45	86
8	71	132	57	108	53	29	48	75
9	71	1,384	32	119	52	28	54	75
10	73	228	32	117	52	27	75	75
11	74	152	32	160	36	26	57	75
12	77	141	54	110	49	32	53	93
13	345	131	50	101	68	33	45	93
14	182	121	59	90	35	30	35	296
15	140	105	43	550	32	29	39	833
16	117	112	51	497	32	28	28	162
17	98	103	41	158	35	24	32	133
18	86	111	36	108	35	24	34	111
19	84	97	90	97	35	24	40	103
20	79	100	64	93	35	25	35	98
21	77	103	96	82	30	26	33	94
22	99	88	2,817	79	29	31	39	105
23	91	84	187	88	31	30	42	94
24	85	81	268	388	41	28	40	84
25	204	74	139	142	33	74	30	80
26	89	73	121	97	34	89	51	73
27	77	70	131	91	33	39	211	75
28	72	68	763	85	36	30	98	75
29	69	67	336	78	49	29	68	77
30	110	67	223	80	45	29	65	82
31	216	.....	184	79	.....	27	.....	111
Mean	95	148	204	147	47	32	71	127

[1] Continued from Water-Supply and Irrigation Paper No. 47.

Daily discharge, in second-feet, of Wissahickon Creek near Philadelphia, Pennsylvania, for 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	118	113	118	143	98	94	44	29	24	19	46	129
2	91	110	115	110	89	93	34	30	24	19	29	107
3	80	113	119	101	73	86	35	68	24	18	24	103
4	74	118	115	93	77	84	35	79	24	18	26	354
5	70	116	110	101	79	80	34	164	23	19	24	923
6	71	108	110	101	79	79	34	108	23	18	23	182
7	75	98	110	101	111	79	34	64	23	16	27	142
8	71	93	103	100	744	77	33	64	22	17	33	125
9	64	93	94	91	256	79	32	66	20	17	29	110
10	68	93	93	87	136	78	32	84	22	16	170	101
11	67	104	96	87	125	74	31	158	22	15	248	93
12	97	146	96	87	125	70	30	125	20	17	82	93
13	136	143	91	87	235	68	30	118	21	19	63	93
14	105	108	91	93	118	68	29	83	21	21	65	93
15	215	108	87	93	281	60	29	76	20	24	75	86
16	177	96	84	87	242	64	30	79	21	25	70	80
17	105	93	86	79	323	70	28	108	21	18	79	79
18	78	93	84	75	139	66	26	416	20	20	125	75
19	75	120	82	75	131	61	28	859	19	29	918	84
20	132	1,512	79	79	155	62	30	123	19	28	176	294
21	223	338	89	79	230	61	32	65	19	37	104	143
22	134	210	101	75	125	55	64	55	19	61	89	129
23	751	158	105	75	110	55	64	44	28	35	140	531
24	193	140	113	108	128	55	32	40	33	26	141	166
25	140	133	113	122	128	54	30	55	25	22	118	122
26	205	130	93	107	146	54	48	42	25	47	118	115
27	201	128	84	98	116	46	243	42	26	70	100	98
28	128	124	104	225	113	125	79	26	21	60	100	80
29	125	.....	157	235	107	79	50	27	20	44	168	84
30	118	.....	357	107	107	60	34	70	19	31	129	101
31	113	.....	138	.....	100	.....	31	67	.....	48	.....	143
Mean	139	176	110	103	162	71	43	111	22	28	118	163

Daily discharge, in second-feet, of Wissahickon Creek near Philadelphia, Pennsylvania, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	141	119	285	191	89	45	18	147	227	273	129	96	.....
2	106	106	245	175	96	42	19	118	350	603	129	90	.....
3	106	110	233	175	103	42	20	116	466	340	123	73	.....
4	120	204	236	173	93	33	21	115	436	202	115	68	.....
5	412	204	1,059	159	80	21	22	106	779	521	106	75	.....
6	574	113	365	151	80	.....	23	106	630	328	106	96	.....
7	573	113	241	166	87	.....	24	259	359	232	106	96	.....
8	220	113	204	451	87	.....	25	925	250	202	106	75	.....
9	194	113	186	205	75	.....	26	184	245	216	106	64	.....
10	154	113	198	152	75	.....	27	142	1,285	198	106	64	.....
11	140	113	198	140	105	.....	28	133	423	434	101	54	.....
12	132	113	198	140	108	.....	29	136	.....	813	98	50	.....
13	118	113	540	140	90	.....	30	136	.....	260	95	59	.....
14	144	113	208	137	87	.....	31	136	.....	218	.....	54	.....
15	149	113	346	129	87	.....							
16	140	113	359	142	87	.....	Mean	207	271	326	146	81	.....
17	232	149	186	142	87	.....							

Daily discharge, in second-feet, of Wissahickon Creek near Philadelphia, Pennsylvania, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	15	47	16	64	18	22	18	13	59	39	25	11	24
2	17	24	15	40	17	24	19	9	152	17	19	12	22
3	20	20	15	17	15	24	20	10	80	17	19	14	21
4	17	16	18	15	15	247	21	18	43	14	21	13	21
5	17	16	15	14	17	219	22	21	27	14	21	12	21
6	17	17	13	14	18	47	23	114	22	12	21	11	21
7	17	20	10	12	14	31	24	114	26	13	20	10	21
8	20	17	9	27	14	38	25	19	31	13	17	11	21
9	17	17	8	54	16	38	26	116	22	10	17	367	20
10	17	15	13	47	15	38	27	83	47	10	14	86	20
11	16	12	13	23	10	52	28	26	40	13	12	26	20
12	40	98	9	15	15	62	29	17	40	13	15	20	20
13	54	31	8	16	18	41	30	176	32	37	17	25	20
14	32	31	9	274	14	24	31	219	27	.....	15	.....	20
15	15	24	12	92	13	31							
16	13	18	278	54	11	30	Mean	42	35	26	34	29	42
17	15	18	85	35	11	26							

SCHUYLKILL RIVER ABOVE PHILADELPHIA, PENNSYLVANIA.

This river is described in Water-Supply Paper No. 35, page 74. Records of the height of the river at Fairmount dam have been kept for many years, but measurements for computing the daily discharge were not made until 1898. The first of the following tables does not represent the total flow of the stream, but the amount wasted over the flashboards at the dam, to which must be added the pumpage from the river, the leakage, and the quantity used for power at Fairmount. The second table is an estimate of the total monthly yield, in cubic feet, including the foregoing items. The figures were furnished by Mr. John E. Codman, hydrographer for the water department of the city of Philadelphia.

Daily discharge, in second-feet, of Schuylkill River above Philadelphia, Pennsylvania, for 1900, being amount wasted over flashboards at Fairmount dam.

Day.	Jan.	Feb.	Mar.	Apr.	May.	July.	Dec.
1	.....	.....	5,526	1,027	.....	.....	.....
2	.....	.....	19,061	880	.....	.....	.....
3	.....	.....	13,197	613	.....	.....	.....
4	.....	.....	7,318	207	.....	.....	425
5	.....	15,673	5,122	148	.....	.....	2,041
6	.....	8,103	3,814	260	.....	.....	2,041
7	.....	3,077	3,814	260	.....	.....	1,362
8	.....	3,890	3,146	378	.....	.....	644
9	.....	5,618	2,277	378	.....	.....	68
10	.....	3,441	2,076	260	.....	.....	.....
11	.....	1,712	2,076	.....	.....	.....	.....
12	7,013	1,348	1,551	.....	.....	.....	.....
13	.....	14,009	1,027	238	.....	.....	.....
14	.....	15,905	1,027	238	.....	.....	.....
15	.....	8,531	1,027	.....	.....	.....	.....
16	.....	5,706	752	.....	.....	.....	.....
17	.....	3,359	369	18	.....	.....	.....
18	.....	2,489	369	35	.....	.....	.....
19	.....	2,076	477	1,697	4,103	.....	.....
20	1,222	1,095	4,243	1,404	6,243	.....	.....
21	3,579	1,349	9,731	497	923	.....	.....
22	2,198	14,183	3,641	411	.....	.....	.....
23	1,275	21,798	2,477	519	.....	80	.....
24	944	12,626	2,689	369	.....	54	.....
25	685	8,235	2,300	130	.....	119	.....
26	675	4,742	1,699	.....	211	2,861	.....
27	450	4,642	2,088	.....	211	2,525	.....
28	225	2,076	2,088	.....	.....	923	.....
29	156	.....	1,524	.....	.....	.....	.....
30	953	.....	1,348	.....	.....	.....	.....
31	.....	.....	1,188	.....	.....	.....	.....

NOTE.—The amount wasted over the flashboards on June 28 was 1,088 second-feet, on August 13 it was 79 second-feet, and on November 27 and 28 it was 43 and 18 second-feet, respectively.

Total monthly yield of Schuykill River above Philadelphia, Pennsylvania, for 1900.

Month.	Yield.	Month.	Yield.
	Cubic feet.		*Cubic feet.*
January	6,610,500,000	July	2,856,566,000
February	33,771,128,000	August	2,040,927,000
March	14,666,146,000	September	1,229,059,000
April	5,730,472,000	October	1,372,271,000
May	5,073,978,000	November	1,579,652,000
June	2,743,671,000	December	3,429,617,000

NORTH BRANCH OF SUSQUEHANNA RIVER AT WILKESBARRE, PENNSYLVANIA.

This station, which was established by E. G. Paul March 30, 1899, is described in Water-Supply Paper No. 35, page 76. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 88. A bench mark was established September 26, 1900, being the extreme west end of the stone doorsill of the north entrance to the Coal Exchange Building, at 32.99 feet above datum of the gage. During 1900 two measurements of discharge were made by Mr. Paul, as follows:

May 20: Gage height, 5.60 feet; discharge, 6,772 second-feet.
September 26: Gage height, 2.20 feet; discharge, 961 second-feet.

The measurement of September 26 was made at Retreat, Pennsylvania, 10 miles below Wilkesbarre.

Daily gage height, in feet, of North Branch of Susquehanna River at Wilkesbarre, Pennsylvania, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.80	7.40	10.40	6.90	6.10	3.80	3.00	3.20	3.10	2.30	2.70	10.50
2	6.20	6.80	17.75	7.50	5.80	3.70	2.80	3.20	3.00	2.30	2.60	9.20
3	6.40	6.30	14.55	9.80	5.50	4.20	2.70	3.00	3.10	2.30	2.60	8.10
4	6.80	6.50	11.80	11.20	5.30	3.90	2.90	2.90	3.00	2.30	2.50	7.40
5	7.00	8.40	9.90	11.10	5.20	3.70	2.90	2.90	2.90	2.30	2.70	9.20
6	7.00	8.50	8.40	9.40	5.00	3.80	3.40	2.90	2.80	2.20	2.80	11.90
7	6.90	7.90	8.20	9.60	4.80	3.70	3.90	2.90	2.70	2.10	3.00	11.30
8	6.80	7.80	8.10	11.70	4.70	3.60	3.60	2.90	2.70	2.10	2.90	9.90
9	6.50	14.45	7.70	12.20	4.60	3.60	3.40	2.90	2.60	2.20	2.90	8.90
10	6.10	9.20	8.40	10.90	4.50	3.80	3.20	2.80	2.60	2.20	2.90	8.20
11	5.80	9.80	9.00	9.20	4.50	3.90	3.10	2.80	2.70	2.20	3.00	7.50
12	5.90	9.20	7.80	7.90	4.80	4.30	2.90	2.70	2.70	2.20	3.10	6.60
13	5.60	9.20	6.80	7.30	4.90	4.30	3.00	2.70	2.70	2.20	3.30	6.20
14	5.90	12.10	6.30	7.70	4.80	4.80	3.00	2.60	2.50	2.20	3.50	6.10
15	5.60	13.65	5.70	8.10	4.70	4.30	3.00	2.60	2.40	2.20	3.50	a10.30
16	5.50	11.80	5.70	7.80	4.70	4.00	3.00	2.60	2.50	2.30	3.40	9.80
17	5.50	9.20	9.00	7.60	4.90	3.80	2.90	2.50	2.40	2.40	3.30	9.20
18	5.20	7.70	8.10	10.03	5.00	3.60	2.90	2.50	2.30	2.40	3.20	8.70
19	5.10	8.90	8.30	12.45	5.10	3.50	2.80	2.40	2.20	2.50	3.20	9.20
20	5.80	10.70	8.50	12.40	5.60	3.40	3.10	2.50	2.20	2.70	3.10	9.60
21	14.65	9.80	10.85	11.10	5.20	3.30	3.20	2.50	2.10	2.60	3.10	9.40
22	16.85	11.40	9.70	10.00	5.00	3.20	3.10	2.50	2.20	2.60	3.20	9.00
23	13.50	16.10	9.20	9.50	4.80	3.50	3.00	2.80	2.20	2.70	3.60	.....
24	10.30	14.75	8.40	11.30	4.60	3.30	2.90	3.00	2.20	2.90	4.00	.....
25	8.50	11.00	9.90	10.70	4.50	3.30	2.90	2.90	2.20	2.80	4.30	.....
26	7.80	8.80	8.70	9.50	4.30	3.20	4.00	2.60	2.20	2.80	4.70	.....
27	7.90	7.00	8.10	8.40	4.10	3.20	3.70	2.70	2.30	2.70	16.75	.....
28	6.20	8.50	7.10	7.50	4.00	3.10	3.40	2.80	2.20	2.70	20.75	.....
29	9.20	.....	7.00	6.90	3.90	3.10	3.20	2.80	2.20	2.70	14.65	.....
30	9.00	.....	6.80	6.50	3.80	3.10	3.30	3.10	2.30	2.70	11.80	11.40
31	8.70	.....	6.50	.....	3.70	.....	3.30	3.10	.....	2.60	.....	11.40

a Ice backed water at gage.

NORTH BRANCH OF SUSQUEHANNA RIVER AT DANVILLE, PENNSYLVANIA.

This station, which was established March 25, 1899, by E. G. Paul, is described in Water-Supply Paper No. 35, page 77. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 89. A bench mark was established, being the extreme south end of the stone doorsill at the east entrance of the city filtering plant, at 31.7 feet above datum of the gage. During 1900 two measurements were made by Mr. Paul, as follows:

May 20: Gage height, 4.60 feet; discharge, 10,515 second-feet.
September 25: Gage height, 1.60 foot; discharge, 822 second-feet.

Daily gage height, in feet, of North Branch of Susquehanna River at Danville, Pennsylvania, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	7.55	5.60	5.35	3.00	2.30	2.40	2.20	1.70	2.00	8.75
2	(a)	(a)	15.25	5.80	5.05	2.90	2.30	2.40	2.20	1.70	2.00	7.15
3	(a)	(a)	13.10	6.75	4.80	2.90	2.30	2.30	2.20	1.70	2.00	5.90
4	(a)	(a)	10.65	8.40	4.55	3.50	2.20	2.20	2.20	1.70	2.00	5.50
5	(a)	(a)	9.25	9.30	4.40	3.30	2.20	2.20	2.20	1.70	2.00	7.10
6	(a)	(a)	7.10	8.45	4.25	3.10	2.30	2.10	2.10	1.70	2.00	8.80
7	(a)	(a)	7.10	7.40	4.15	3.00	2.70	2.50	2.10	1.70	2.00	9.65
8	(a)	(a)	7.30	8.70	4.05	2.90	2.90	2.20	2.00	1.70	2.00	8.55
9	(a)	9.70	6.85	9.75	4.00	2.90	2.90	2.10	1.80	1.70	2.00	7.50
10	(a)	9.90	6.75	9.45	3.95	2.90	2.70	2.10	1.90	1.70	2.00	6.85
11	(a)	7.60	7.50	8.25	3.85	3.10	2.50	2.00	1.80	1.70	2.10	6.30
12	(a)	7.80	7.20	7.10	3.90	3.10	2.50	2.00	1.80	1.70	2.10	5.55
13	(a)	9.40	6.40	6.30	4.10	3.30	2.40	1.90	1.80	1.70	2.20	5.20
14	(a)	9.60	5.65	6.10	4.20	3.30	2.30	2.00	1.80	1.70	2.40	5.00
15	(a)	11.20	5.20	6.30	4.00	3.90	2.30	2.00	1.80	1.80	2.40	5.00
16	(a)	10.40	4.90	6.65	4.00	3.50	2.30	1.90	1.80	1.80	2.60	6.80
17	(a)	8.30	4.70	6.35	3.80	3.20	2.30	1.90	1.70	1.80	2.50	(a)
18	(a)	7.30	4.90	7.00	3.90	3.00	2.30	1.90	1.70	1.80	2.50	(a)
19	(a)	5.70	5.05	9.75	3.90	3.00	2.30	1.80	1.70	1.80	2.50	(a)
20	(a)	5.00	5.10	10.55	4.40	2.90	2.30	1.80	1.70	1.80	2.50	(a)
21	9.40	4.70	7.95	9.85	4.40	2.80	2.20	1.90	1.70	1.70	2.50	(a)
22	12.70	5.95	8.80	8.95	4.10	2.70	2.40	1.90	1.70	1.70	2.50	(a)
23	11.95	12.15	7.95	8.10	3.90	2.60	2.30	1.80	1.60	1.90	2.60	(a)
24	9.70	13.50	7.40	8.35	3.70	2.60	2.20	1.80	1.60	2.10	2.70	(a)
25	7.80	11.05	7.40	9.30	3.60	2.70	2.10	2.30	1.60	2.30	2.90	(a)
26	6.80	8.95	7.65	8.40	3.60	2.60	2.30	2.10	1.70	2.20	3.90	7.05
27	6.45	6.85	6.95	7.40	3.40	2.50	3.00	2.20	1.70	2.10	8.45	8.60
28	6.30	5.45	6.50	6.65	3.20	2.50	2.80	2.10	1.70	2.10	16.60	7.55
29	5.80	.....	5.85	6.10	3.20	2.40	2.60	2.00	1.70	2.10	12.65	6.95
30	5.80	.....	5.90	5.65	3.10	2.40	2.40	2.00	1.70	2.00	10.20	6.55
31	(a)	.....	5.65	.....	3.00	.....	2.40	2.00	.....	2.00	.....	6.30

a River frozen.

WEST BRANCH OF SUSQUEHANNA RIVER AT ALLENWOOD, PENNSYLVANIA.

This station, which was established by E. G. Paul March 23, 1899, is described in Water-Supply Paper No. 35, page 78. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 90. A bench mark was established on September 24, 1900. It consists of a copper bolt set in the capstone of the wing wall on the lower side of the west end of the bridge, and is 33.19 feet above datum of the gage. During 1900 two measurements of discharge were made by Mr. Paul, as follows:

May 19: Gage height, 3.2 feet; discharge, 4,812 second-feet.
September 24: Gage height, 1.8 feet; discharge, 511 second-feet.

Daily gage height, in feet, of West Branch of Susquehanna River at Allenwood, Pennsylvania, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.50	3.20	7.55	5.00	4.30	3.90	2.10	1.90	2.00	1.30	2.10	5.75
2	5.50	3.20	9.60	5.30	4.20	3.90	2.30	1.80	1.90	1.30	2.10	5.40
3	5.70	3.40	7.70	5.40	4.20	3.90	2.60	1.80	1.90	1.20	2.10	5.00
4	5.80	3.40	7.00	5.80	4.00	4.00	2.50	1.80	1.80	1.20	2.10	5.80
5	5.90	3.50	6.00	5.90	3.80	4.10	2.30	1.70	1.80	1.20	2.10	5.90
6	5.90	3.60	5.40	6.20	3.50	3.90	2.30	1.70	1.70	1.20	2.00	6.40
7	5.90	3.80	5.80	6.40	3.30	3.60	2.20	1.70	1.70	1.20	1.90	6.70
8	4.70	4.50	5.90	6.20	3.30	3.50	2.20	1.60	1.70	1.20	1.90	6.00
9	3.70	5.00	6.10	7.30	3.20	3.40	2.20	1.60	1.60	1.80	1.90	5.50
10	3.90	5.30	6.40	6.00	3.20	3.30	2.30	1.50	1.60	2.20	1.90	4.90
11	4.20	5.60	6.90	5.70	3.20	3.20	2.50	1.40	1.60	2.20	1.90	4.60
12	4.50	5.30	6.20	5.30	3.20	3.00	2.70	1.50	1.50	2.10	1.90	4.20
13	4.40	6.00	5.40	4.90	3.50	3.00	2.90	1.50	1.50	2.10	1.90	4.00
14	4.20	7.70	5.00	4.80	3.40	3.00	2.80	1.40	1.40	2.10	1.90	3.80
15	4.00	7.30	4.00	4.80	3.40	3.00	2.60	1.40	1.40	2.10	1.90	3.60
16	4.00	6.50	4.00	4.60	3.30	3.00	2.60	1.40	1.40	2.10	1.80	3.30
17	4.00	6.20	3.90	4.70	3.20	2.90	2.50	1.40	1.30	2.10	1.80	3.20
18	4.20	5.40	3.80	6.00	3.20	2.80	2.40	1.40	1.30	2.20	1.80	3.20
19	4.50	5.60	3.70	7.00	3.50	2.70	2.20	1.40	1.30	2.10	1.70	3.10
20	5.30	5.90	6.20	6.90	3.50	2.70	2.00	1.40	1.30	2.00	1.70	3.10
21	13.20	6.00	7.10	6.30	3.30	2.60	2.00	1.40	1.30	1.90	1.70	3.10
22	12.20	8.20	6.90	6.20	3.20	2.50	1.90	2.30	1.30	1.90	1.90	3.00
23	8.50	10.15	6.60	6.00	3.00	2.40	1.90	2.30	1.30	2.10	2.40	3.00
24	6.50	7.85	6.10	6.30	3.00	2.40	1.90	2.30	1.30	2.20	3.00	3.00
25	6.30	6.50	5.90	6.00	3.00	2.30	1.90	2.30	1.30	2.40	5.00	3.00
26	6.10	5.00	5.50	5.60	3.00	2.30	1.90	2.30	1.30	2.50	7.70	3.00
27	5.30	5.00	5.20	5.30	3.40	2.30	2.20	2.20	1.30	2.60	15.75	3.00
28	4.60	4.80	5.10	4.80	3.20	2.20	2.20	2.20	1.30	2.40	10.05	3.00
29	4.60	.....	5.00	4.60	3.00	2.20	2.20	2.10	1.30	2.40	8.25	3.00
30	4.50	.....	4.90	4.40	3.00	2.10	2.20	2.10	1.30	2.30	6.60	3.00
31	3.20	.....	4.80	.....	3.20	.....	2.00	2.00	.....	2.20	.....	.....

JUNIATA RIVER AT NEWPORT, PENNSYLVANIA.

This station, which was established March 21, 1899, by E. G. Paul, is described in Water-Supply Paper No. 35, page 79. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 91. The bench mark is the extreme east end of the stone doorsill of the south entrance of Butz's store, on the right bank, and is 28.83 feet above datum of the gage. During 1900 two measurements of discharge were made by Mr. Paul, as follows:

May 17: Gage height, 3.40 feet; discharge, 1,778 second-feet.
September 22: Gage height, 2.80 feet; discharge, 418 second-feet.

Daily gage height, in feet, of Juniata River at Newport, Pennsylvania, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.10	3.70	5.90	4.50	4.10	3.30	3.30	3.00	3.30	2.80	3.00	4.40
2	4.10	3.40	12.90	4.50	4.10	3.30	3.20	3.00	3.20	2.90	3.00	4.10
3	4.60	3.40	8.00	4.50	4.00	3.40	3.10	3.00	3.20	3.00	3.00	3.90
4	5.00	3.50	6.00	4.40	3.90	3.70	3.10	3.00	3.10	3.00	3.00	3.90
5	5.00	3.80	5.50	4.50	3.80	3.60	3.10	3.00	2.90	2.90	2.90	5.50
6	4.70	4.40	5.40	4.60	3.70	3.40	3.10	3.00	2.90	2.90	2.90	7.00
7	5.20	4.10	6.00	4.50	3.70	3.40	3.10	2.90	2.90	2.90	3.00	6.30
8	4.00	4.20	6.40	4.40	3.70	3.30	3.10	2.90	2.80	2.90	3.00	5.20
9	4.20	5.10	5.60	4.40	3.60	3.40	3.10	2.90	2.80	2.90	3.00	4.60
10	4.10	5.60	5.40	4.40	3.60	3.50	3.10	2.80	2.80	2.90	3.00	4.50
11	4.10	4.80	5.10	4.40	3.50	3.40	3.10	2.80	2.80	2.90	2.90	4.30
12	4.80	4.60	5.10	4.30	3.50	3.30	3.10	2.80	2.80	3.00	2.90	4.20
13	4.60	5.40	4.90	4.30	3.50	3.30	3.10	2.80	2.80	3.00	2.90	4.00
14	4.20	9.40	4.80	4.30	3.50	3.30	3.00	2.80	2.80	3.00	2.90	3.80
15	3.90	7.60	4.70	4.30	3.50	3.30	3.00	2.80	2.80	3.00	3.00	3.70
16	3.50	5.90	4.60	4.10	3.50	3.30	3.00	2.80	2.80	3.00	3.00	3.70
17	4.10	5.30	4.10	4.00	3.40	3.30	3.00	2.80	2.80	3.00	3.00	3.60
18	3.80	4.90	4.10	4.00	3.40	3.30	3.00	2.80	2.80	3.00	3.00	3.30
19	4.20	4.10	4.10	4.40	3.50	3.30	2.90	2.80	2.80	3.00	3.00	3.50
20	4.90	4.20	4.40	4.70	3.70	3.30	2.90	2.80	2.80	3.00	3.00	3.70
21	10.60	4.40	6.50	4.50	4.00	3.30	2.90	2.80	2.80	3.00	3.00	3.80
22	10.20	11.70	6.50	4.50	3.70	3.30	2.90	2.80	2.80	3.00	3.00	3.80
23	7.20	11.10	5.70	4.50	3.70	3.30	2.90	2.80	2.80	2.90	3.10	3.60
24	6.00	8.20	5.70	4.70	3.60	3.30	3.20	2.80	2.80	3.70	3.10	3.40
25	5.20	5.90	5.60	4.70	3.50	3.20	3.10	3.30	2.80	3.40	4.00	3.80
26	5.00	4.50	5.40	4.70	3.50	3.20	3.10	3.30	2.80	3.30	6.30	3.50
27	4.80	4.40	5.10	4.40	3.20	3.60	3.10	3.70	2.80	3.30	11.60	3.30
28	4.40	4.60	5.00	4.30	3.30	3.40	3.10	3.40	2.80	3.20	8.00	3.20
29	4.40	.....	4.80	4.20	3.30	3.30	3.00	3.30	2.80	3.20	5.70	3.20
30	4.20	.....	4.60	4.20	3.30	3.30	3.00	3.70	2.80	3.10	4.80	3.20
31	4.10	.....	4.50	.....	3.30	.....	3.00	3.60	.....	3.00	.....	3.20

SUSQUEHANNA RIVER AT HARRISBURG, PENNSYLVANIA.

Gage-height observations were established at this station by E. Mather, president of the Harrisburg water board, in 1890. Discharge measurements were first made by E. G. Paul on March 31, 1897, from the Walnut street bridge. The station is described in Water-Supply Paper No. 35, page 80. The datum of this gage is the low-water mark of 1803, which is recorded on a large rock above the bridge. During 1900 three measurements were made by Mr. Paul, as follows:

May 16: Gage height, 2.42 feet; discharge, 17,621 second-feet.
September 21: Gage height, 0.08 foot; discharge, 2,655 second-feet.
September 28: Gage height, −0.04 foot; discharge, 2,357 second-feet.

Daily gage height, in feet, of Susquehanna River at Harrisburg, Pennsylvania, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.83	2.91	4.00	4.16	4.00	2.58	1.17	1.25	1.00	0.04	0.83	7.00
2	1.66	1.83	13.12	4.00	3.75	2.50	1.08	1.00	1.00	.04	.83	5.83
3	4.50	3.91	12.33	4.16	3.50	2.33	1.00	1.00	.83	.04	.75	5.25
4	4.91	4.00	9.50	4.41	3.33	2.17	1.08	.92	1.17	.06	.75	4.50
5	4.83	4.66	7.91	5.33	3.08	2.50	1.33	.75	.92	.04	.75	5.00
6	5.25	4.33	6.91	6.00	2.83	2.67	1.17	.67	.83	.04	.66	7.25
7	5.50	5.50	6.00	5.41	2.83	2.50	1.33	.67	.58	.04	.66	7.41
8	5.33	5.00	6.16	5.08	2.75	2.17	1.17	.58	.58	.08	.66	7.08
9	4.91	4.00	6.50	6.16	2.50	2.17	1.42	.50	.58	.04	.75	6.00
10	4.58	4.83	5.83	6.75	2.50	2.08	1.42	.58	.50	.04	.58	5.25
11	4.50	5.75	5.66	6.50	2.42	2.00	1.33	.50	.42	.04	.66	4.75
12	5.50	5.50	6.25	5.58	2.33	2.00	1.17	.33	.33	.04	.50	4.08
13	4.91	5.66	5.75	5.00	2.42	1.92	1.08	.33	.17	.25	.58	3.83
14	5.25	7.66	4.66	4.50	2.42	1.92	1.08	.25	.25	.83	.75	3.60
15	5.25	8.00	4.50	4.33	2.50	2.00	1.00	.17	.25	.83	.66	2.91
16	5.25	8.25	4.00	4.50	2.40	2.17	1.00	.17	.25	.75	.66	2.85
17	4.66	7.41	3.66	4.41	2.33	2.17	1.00	.25	.25	.58	.83	2.25
18	5.00	6.00	3.16	4.33	2.33	2.00	1.08	.17	.17	.66	.91	2.08
19	4.83	4.75	3.00	5.08	2.25	1.83	.92	.17	.08	.66	.75	2.08
20	4.00	3.91	3.00	7.08	2.50	1.83	.92	.17	.12	.58	.91	2.08
21	4.25	2.16	3.91	7.33	2.92	1.82	.83	.33	.08	.50	.91	2.00
22	10.66	3.58	6.87	6.83	2.17	1.75	.75	.42	.07	.50	.91	2.16
23	12.00	9.50	6.83	6.08	2.83	1.75	.75	.83	.06	.50	.83	2.41
24	9.16	11.16	6.00	5.83	2.58	1.58	.75	.50	.04	.50	1.00	2.16
25	7.25	9.75	5.75	6.00	2.42	1.42	.75	1.25	.04	1.00	1.08	2.33
26	6.08	6.83	5.83	6.25	2.25	1.33	.83	1.00	.02	1.08	1.66	2.41
27	5.00	5.50	5.50	5.75	2.17	1.33	1.50	1.17	.00	1.00	5.91	2.00
28	4.50	4.50	5.25	5.08	2.00	1.33	1.25	1.50	—0.04	1.25	13.04	2.66
29	4.08	.....	4.83	4.58	2.00	1.33	1.25	1.33	—0.04	1.16	12.33	2.91
30	3.33	.....	4.50	4.17	2.00	1.17	1.42	1.00	+0.04	1.00	8.91	2.58
31	2.50	.....	4.41	.....	1.92	.....	1.25	1.08	.....	.91	.....	2.50

MISCELLANEOUS DISCHARGE MEASUREMENTS IN PENNSYLVANIA.

During the year 1900 the following measurements of the Pennsylvania Canal and of Lehigh River were made by E. G. Paul:

Miscellaneous discharge measurements in Pennsylvania during 1900.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
May 16	Pennsylvania Canal	Harrisburg	376
May 18	do	do	369
September 21	do	do	360
May 18	do	Steelton	192
September 23	do	do	161
May 18	do	Highspire	152
September 23	do	do	150
September 26	do	Nanticoke	328
September 27	Lehigh River	Easton, Glendon Bridge	303

PATAPSCO RIVER AT WOODSTOCK, MARYLAND.

This station, which was established August 6, 1896, by E. G. Paul, is located at the county bridge on the road from Woodstock to Granite, Maryland, 1½ miles below the junction of the North Branch. It is described in Water-Supply Paper No. 35, page 83, where will also be found the gage heights for 1899. The discharge measurements for 1899 were published in the Twenty-first Annual Report, Part IV, page 94. During 1900 the following measurements were made by Mr. Paul:

June 29: Gage height, 3.6 feet; discharge, 165 second-feet.
September 29: Gage height, 3.6 feet; discharge, 152 second-feet.

Daily gage height, in feet, of Patapsco River at Woodstock, Maryland, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.a
1	3.90	3.85	6.50	4.00	3.90	3.60	3.60	3.25	5.30	3.55	3.45
2	3.90	3.75	4.90	4.15	3.90	3.55	3.65	3.30	5.30	3.55	3.45
3	3.95	3.70	4.55	4.15	4.00	3.60	3.60	3.25	5.40	3.55	3.50
4	3.95	3.40	4.40	4.15	3.95	3.65	3.45	3.15	5.30	3.50	3.50
5	3.90	4.40	4.35	4.10	4.00	3.75	3.55	3.15	4.85	3.35	3.50
6	3.85	3.90	4.40	4.15	4.00	3.65	4.00	3.10	5.20	3.35	3.50
7	.....	3.85	4.40	4.15	4.05	3.65	3.85	3.00	5.20	3.30	3.45
8	4.05	4.10	4.40	4.10	3.90	3.75	3.55	3.00	5.25	3.35	3.50
9	3.85	4.25	4.25	4.15	4.10	3.85	3.55	3.00	5.25	3.55	3.45
10	3.85	4.05	4.30	4.15	3.95	3.30	3.55	3.05	5.25	3.55	3.45
11	3.85	4.05	4.20	4.35	4.00	3.65	3.45	3.05	5.25	3.55	3.45
12	5.25	4.10	4.25	4.35	3.90	3.55	3.35	3.00	5.35	3.55	3.85
13	3.95	7.65	4.20	4.35	4.00	3.60	3.35	3.05	5.35	3.35	3.55
14	3.85	5.15	4.25	4.20	3.85	3.60	3.25	3.00	5.40	3.30	3.45
15	3.80	4.30	4.25	4.10	3.90	4.00	3.15	3.00	5.55	3.75	3.45
16	3.85	4.15	4.35	4.15	4.00	(b)	3.05	3.00	5.30	3.65	3.45
17	3.95	.....	.....	4.20	4.00	(b)	3.00	3.10	5.40	3.55	3.45
18	3.95	3.85	4.10	4.10	3.90	(b)	3.05	3.00	5.10	3.45	3.40
19	3.90	3.95	4.00	4.10	4.30	(b)	3.05	3.10	5.10	3.25	3.45
20	4.50	3.95	4.20	4.15	4.20	(b)	3.05	5.20	5.05	3.40	3.45
21	5.60	4.00	6.60	4.25	4.10	(b)	3.00	6.10	5.05	3.30	3.45
22	4.15	8.70	4.90	4.10	3.75	(b)	3.50	5.95	5.05	3.45	3.50
23	4.05	4.95	4.35	4.15	3.75	(b)	3.20	5.75	5.05	3.45	3.40
24	4.05	4.55	4.35	4.20	3.70	(b)	3.55	5.65	5.15	3.45	3.50
25	4.00	3.90	4.30	4.05	3.75	(b)	7.15	5.55	5.00	3.50	3.30
26	3.90	4.30	4.10	4.00	3.80	(b)	6.35	5.40	5.10	3.45	3.40
27	3.85	4.15	4.30	3.90	3.90	(b)	5.75	5.40	5.05	3.50	3.40
28	3.85	4.35	4.20	3.90	3.80	(b)	4.50	5.70	4.95	3.45	3.35
29	3.85	.....	4.20	3.80	3.80	(b)	4.50	5.40	4.20	3.45	3.45
30	3.85	.....	4.40	4.00	3.65	(b)	4.45	5.45	3.50	3.45	3.40
31	3.85	.....	4.20	.....	3.35	.....	5.05	5.40	.....	3.45	.....

a No record for December. b June 16 to 30, no readings: gage broken.

NORTH BRANCH OF POTOMAC RIVER AT PIEDMONT, WEST VIRGINIA.

This station, which was established January 27, 1899, by E. G. Paul, is located at the highway bridge connecting Luke, Maryland, with Piedmont, West Virginia. It is described in Water-Supply Paper No. 35, page 84, where will be found gage heights and discharge measurements for 1899. During 1900 the following measurements were made by Mr. Paul:

February 22: Gage height, 3.75 feet; discharge, 735 second-feet.
June 20: Gage height, 4.40 feet; discharge, 1,249 second-feet.
September 12: Gage height, 1.8 feet; discharge, 34 second-feet.

Daily gage height, in feet, of North Branch of Potomac River at Piedmont, West Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	3.00	3.55	4.60	3.15	3.30	3.00	2.95	2.10	2.85	2.10	3.55
2	2.70	3.05	4.50	4.80	3.10	3.25	2.85	2.75	2.00	2.45	2.10	3.45
3	2.70	3.10	4.10	4.65	3.10	3.25	2.70	2.65	2.00	2.20	2.25	3.25
4	2.70	3.10	4.00	4.50	3.10	3.05	2.70	2.60	2.00	2.10	2.65	5.80
5	2.70	3.35	4.30	4.25	3.00	2.90	2.70	2.40	2.00	2.20	2.70	5.65
6	2.80	3.60	4.25	4.15	2.95	2.85	2.60	2.30	1.95	2.20	2.50	4.70
7	2.90	3.70	5.80	4.15	2.90	2.85	2.70	2.30	1.90	2.20	2.40	4.25
8	3.00	5.30	5.00	4.30	2.90	3.15	3.00	2.20	1.90	2.10	2.30	4.00
9	3.30	5.40	4.55	4.20	2.95	3.15	2.85	2.20	1.90	2.05	2.40	3.80
10	3.50	4.65	4.40	3.95	3.20	2.95	2.70	2.10	1.90	2.00	2.50	3.60
11	3.50	4.40	4.30	3.75	3.05	2.80	2.60	2.05	1.80	2.00	2.50	3.40
12	4.70	4.05	4.15	3.70	3.00	2.70	2.45	2.00	1.80	2.00	2.60	3.40
13	4.25	5.90	4.10	3.65	2.90	2.70	2.60	2.10	1.80	2.00	2.60	3.40
14	3.90	5.50	4.10	3.55	2.80	3.15	2.65	2.00	1.80	3.05	2.50	3.30
15	3.90	4.80	4.00	3.40	2.80	3.20	2.55	2.00	1.80	3.20	2.50	3.30
16	3.90	4.35	3.80	3.40	2.80	3.95	2.35	2.10	1.80	2.65	2.40	3.20
17	4.40	4.15	3.70	3.40	2.80	7.55	2.30	2.40	1.90	2.45	2.40	3.05
18	4.10	4.05	3.70	3.55	2.70	5.85	2.25	2.25	1.90	2.40	2.40	3.15
19	4.15	3.70	4.00	3.75	3.40	4.95	2.35	2.25	1.90	2.25	2.40	3.20
20	5.80	3.65	5.95	3.65	3.95	4.45	2.90	2.45	1.90	2.20	2.50	3.25
21	5.70	3.60	5.35	3.50	3.55	3.95	2.75	2.20	1.80	2.10	2.60	3.25
22	4.75	3.75	4.75	3.50	3.35	3.65	2.55	2.20	1.80	2.10	3.20	3.05
23	4.35	4.00	4.60	3.65	3.20	3.50	2.45	2.65	1.80	2.15	3.00	3.00
24	4.10	3.70	4.60	3.85	3.15	3.35	2.40	2.45	1.80	2.35	2.90	3.05
25	3.95	3.60	4.50	3.65	3.05	3.25	3.20	2.40	1.80	2.80	3.35	3.05
26	3.80	3.40	4.25	3.50	3.00	3.25	4.05	2.45	1.80	2.50	7.95	3.05
27	3.55	3.40	4.35	3.40	2.95	3.05	4.40	2.45	1.85	2.35	5.20	2.90
28	3.40	3.40	4.15	3.40	2.90	2.90	3.20	2.30	1.90	2.30	4.45	2.90
29	3.30	.....	4.00	3.30	3.30	3.55	3.00	2.20	1.95	2.20	4.05	3.45
30	3.20	.....	4.75	3.25	3.25	3.15	3.00	2.15	2.70	2.20	3.75	3.05
31	3.10	.....	4.60	.....	3.10	.....	3.25	2.10	.....	2.20	.....	3.30

SOUTH BRANCH OF POTOMAC RIVER NEAR SPRINGFIELD, WEST VIRGINIA.

The station on the South Branch at Springfield was originally (April, 1894) established at the railroad bridge 2 miles south of that town, by C. C. Babb, but was discontinued in 1896. The present station, which was established by E. G. Paul, January 26, 1899, is located on the iron highway bridge one-fourth of a mile from Grace Station and 1 mile from Springfield. It is described in Water-Supply Paper No. 35, page 85, where will also be found the gage heights and discharge measurement for 1899. During 1900 the following measurements were made by Mr. Paul:

February 23: Gage height, 7.7 feet; discharge, 3,808 second-feet.
June 20: Gage height, 7 feet; discharge, 3,435 second-feet.
September 11: Gage height, 4 feet; discharge, 144 second-feet.

Daily gage height, in feet, of South Branch of Potomac River near Springfield, West Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	9.8	7.4	4.4	4.0	5.0	3.6	3.5	4.0	3.6	5.2
2	(a)	(a)	8.4	7.0	4.3	4.8	5.0	3.4	3.4	3.8	3.6	5.0
3	(a)	(a)	6.8	6.5	4.2	4.4	5.0	3.4	3.4	3.7	3.6	5.0
4	(a)	(a)	6.8	5.6	4.2	4.4	5.2	3.4	3.4	3.5	4.0	5.0
5	(a)	(a)	6.4	5.2	4.1	4.2	5.2	3.4	3.3	3.4	4.0	5.9
6	(a)	(a)	6.2	5.2	4.1	4.2	5.0	3.2	3.3	3.4	3.8	10.6
7	(a)	(a)	7.0	5.0	4.1	4.1	5.0	3.2	3.2	3.6	3.8	12.0
8	(a)	(a)	7.8	5.0	4.0	4.0	4.7	3.2	3.1	3.6	3.6	10.0
9	(a)	(a)	9.4	4.8	4.0	4.0	4.4	3.1	3.8	3.5	3.6	5.0
10	(a)	5.8	6.0	4.6	4.0	4.0	4.4	3.0	4.5	3.5	3.6	5.0
11	(a)	6.0	7.4	4.2	4.0	3.9	4.2	3.0	4.0	3.5	3.5	4.8
12	(a)	6.4	6.8	4.2	3.9	3.9	4.0	3.0	4.0	3.3	3.4	4.7
13	(a)	6.4	6.2	4.0	3.8	3.9	3.6	3.0	3.6	3.2	3.8	4.7
14	(a)	6.8	5.7	4.0	3.8	5.6	3.2	3.0	3.4	3.2	3.2	4.5
15	(a)	7.2	5.4	3.8	3.7	5.2	3.2	3.0	3.0	3.8	3.2	4.5
16	4.2	7.0	5.0	3.5	3.6	7.6	3.2	2.9	3.0	3.7	3.1	4.4
17	4.6	6.8	4.8	3.4	3.6	13.0	3.1	2.9	2.9	3.6	3.1	(a)
18	4.8	(a)	4.6	3.4	3.6	10.2	3.1	2.9	2.9	3.6	3.1	(a)
19	4.9	(a)	5.0	3.2	3.5	9.5	3.0	2.9	2.9	3.6	3.4	(a)
20	5.0	(a)	7.8	4.4	4.0	7.0	3.0	2.9	2.8	3.5	3.4	4.2
21	9.0	(a)	11.4	5.6	3.7	5.4	3.0	2.8	2.8	3.5	3.6	4.0
22	7.0	6.4	10.8	6.0	3.5	5.1	3.4	3.2	2.8	3.5	3.8	4.0
23	6.8	7.7	9.2	6.8	3.4	5.0	3.6	3.4	3.0	3.5	3.8	3.8
24	6.2	7.4	8.4	6.2	3.4	4.9	3.8	3.4	3.0	3.4	3.8	3.7
25	5.6	(a)	7.6	6.0	3.2	4.9	3.8	3.4	3.0	3.2	4.0	3.7
26	5.2	(a)	6.5	5.6	3.1	5.2	4.6	4.2	3.0	3.2	10.2	3.6
27	(a)	(a)	6.4	5.2	3.4	5.4	5.0	4.0	3.0	3.2	12.0	3.5
28	(a)	(a)	6.1	5.0	3.4	5.6	5.4	4.0	3.4	3.2	9.8	3.5
29	(a)	.....	6.8	4.7	3.5	5.6	5.4	3.8	3.5	3.4	8.2	3.5
30	(a)	.....	7.4	4.4	3.6	5.4	4.5	3.6	4.0	3.5	6.8	3.4
31	(a)	.....	7.8	.....	4.0	.....	4.0	3.5	.....	.....	.....	3.4

a Ice.

ANTIETAM CREEK NEAR SHARPSBURG, MARYLAND.

This station was established at Myers's mill, 1 mile east of Sharpsburg, Maryland, on the road to Keedysville, Maryland, on June 24, 1897, by Arthur P. Davis. It is described in Water-Supply Paper No. 35, page 86, where will be found the gage heights for 1899. Records of discharge measurements for the year 1899 will be found in the Twenty-first Annual Report, Part IV, page 95. During 1900 the following measurements were made by E. G. Paul:

June 28: Gage height, 1.80 feet; discharge, 139 second-feet.
September 16: Gage height, 1.75 feet; discharge, 131 second-feet.

Daily gage height, in feet, of Antietam Creek near Sharpsburg, Maryland, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.60	3.80	2.50	2.10	2.00	1.70	1.40	1.60	1.40	1.70	1.55
2	1.50	1.70	3.60	2.50	2.10	1.90	1.70	1.40	1.60	1.50	1.50	1.55
3	1.50	1.60	3.00	2.40	2.00	1.90	1.60	1.50	1.40	1.40	1.50	1.50
4	1.60	1.50	2.80	2.30	2.10	2.00	1.50	1.50	1.60	1.40	1.50	2.30
5	1.60	1.50	2.70	2.30	2.00	1.90	1.70	1.40	1.70	1.50	1.50	2.40
6	1.70	1.60	2.70	2.30	1.90	1.90	1.70	1.40	1.60	1.40	1.40	2.00
7	1.70	1.50	2.75	2.40	2.10	1.90	1.60	1.40	1.50	1.40	1.50	1.60
8	1.80	2.00	2.60	2.30	2.00	1.90	1.60	1.40	1.50	1.30	1.60	1.70
9	1.90	2.20	2.50	2.80	2.00	1.90	1.70	1.45	1.40	1.50	1.60	1.70
10	1.80	2.00	2.50	2.20	1.90	1.70	1.60	1.50	1.40	1.60	1.60	1.60
11	1.80	1.90	2.50	2.20	1.80	2.00	1.50	1.40	1.40	1.60	1.50	1.60
12	1.80	2.00	2.50	2.30	1.90	1.90	1.55	1.50	1.40	1.50	1.40	1.50
13	1.70	2.70	2.40	2.30	1.80	1.80	1.50	1.50	1.50	1.50	1.70	1.50
14	1.70	2.70	2.40	2.30	1.80	1.70	1.55	1.40	1.60	2.05	1.50	1.50
15	1.80	2.40	2.40	2.20	2.00	1.70	1.60	1.70	1.60	1.90	1.70	1.40
16	1.70	2.40	2.40	2.30	1.90	1.85	1.45	1.60	1.80	1.70	1.50	1.30
17	1.70	2.20	2.30	2.20	2.00	2.10	1.50	1.60	.....	1.60	1.50	1.50
18	1.70	2.10	2.25	2.30	2.00	2.20	1.50	1.60	1.40	1.40	1.40	1.40
19	1.80	2.20	2.40	2.35	2.40	2.55	1.50	1.60	1.50	1.60	1.50	1.50
20	2.10	2.20	2.90	2.30	3.10	2.10	1.60	1.70	1.50	1.60	1.50	1.50
21	2.50	2.30	3.10	2.70	2.40	2.00	1.50	1.80	1.50	1.40	1.60	1.50
22	2.00	4.15	2.80	2.30	2.20	1.90	1.40	1.80	1.40	1.50	1.50	1.50
23	1.90	3.75	2.70	2.40	2.10	1.80	1.90	1.70	1.30	1.50	1.50	1.50
24	1.80	3.05	2.70	2.30	2.10	1.70	1.85	1.70	1.40	1.80	1.50	1.40
25	1.70	3.80	2.60	2.20	2.10	1.80	1.65	1.80	1.40	1.70	1.50	1.30
26	2.30	3.30	2.50	2.20	2.00	1.80	2.00	1.70	1.40	1.50	2.50	1.60
27	2.20	3.00	2.60	2.10	1.90	1.90	1.90	1.70	1.40	1.50	2.10	1.50
28	2.00	3.00	2.50	2.10	1.90	1.80	1.80	2.00	1.40	1.40	1.80	1.50
29	1.80	.....	2.50	2.10	2.00	1.80	1.55	1.90	1.50	1.30	1.70	1.50
30	1.60	.....	2.60	2.00	1.90	1.70	1.40	1.80	1.60	1.40	1.60	1.40
31	1.60	.....	2.60	.....	2.10	.....	1.40	1.70	.....	1.60	.....	1.50

NORTH AND SOUTH RIVERS AT PORT REPUBLIC, VIRGINIA.

These stations were established in August, 1895. They are described in Water-Supply Paper No. 35, page 86, where records of past measurements will be found. Both stations were discontinued on April 1, 1899.

NORTH BRANCH OF SHENANDOAH RIVER NEAR RIVERTON, VIRGINIA.

This station, which was established June 26, 1899, by Arthur P. Davis, is about 2 miles northwest of Riverton. It is described in Water-Supply Paper No. 35, page 88, where will be found records of discharge measurements made during 1899. During 1900 the following measurements were made by E. G. Paul:

February 13: Gage height, 3.25 feet; discharge, 645 second-feet.
June 18: Gage height, 5.30 feet; discharge, 2,923 second-feet.
September 10: Gage height, 2.60 feet; discharge, 146 second-feet.

Daily gage height, in feet, of North Branch of Shenandoah River near Riverton, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	4.00	4.05	3.70	3.25	2.80	2.90	2.73	2.60	3.80	3.70	4.15
2	3.00	4.00	6.85	3.58	3.18	2.80	2.90	2.65	2.60	3.80	3.73	3.93
3	3.00	4.00	5.55	3.53	3.15	2.80	2.85	2.60	2.63	3.75	3.70	4.03
4	3.00	4.00	4.40	3.48	3.10	2.90	2.78	2.55	2.63	3.70	3.75	4.48
5	3.00	3.90	4.10	3.40	3.05	2.85	2.73	2.53	2.58	3.70	3.70	6.10
6	3.00	3.50	3.88	3.33	3.05	2.83	2.73	2.50	2.60	3.70	3.70	5.70
7	3.00	3.38	3.83	3.28	3.00	2.80	2.70	2.50	2.60	3.78	3.70	5.15
8	3.00	3.10	3.75	3.25	2.98	2.80	2.70	2.55	2.58	3.80	3.70	4.70
9	3.00	3.00	3.68	3.20	2.95	2.80	2.68	2.58	2.60	3.70	3.65	4.45
10	3.00	2.95	3.60	3.15	2.93	2.80	2.68	2.60	3.10	3.70	3.63	4.45
11	3.00	3.00	3.50	3.15	2.90	2.75	2.63	2.60	3.60	3.68	3.70	4.35
12	3.00	2.98	3.40	3.15	2.90	2.73	2.63	2.58	3.60	3.65	3.60	4.00
13	3.00	3.13	3.35	3.15	2.90	2.70	2.65	2.50	3.58	3.70	3.60	3.95
14	2.98	4.10	3.35	3.15	2.90	2.73	2.65	2.50	3.60	3.70	3.68	3.95
15	2.93	4.20	3.35	3.10	2.90	2.75	2.63	2.50	3.60	3.70	3.65	4.00
16	2.90	3.88	3.35	3.10	2.83	2.78	2.60	2.50	3.70	3.70	3.60	3.95
17	2.80	3.63	3.30	3.10	2.80	3.45	2.68	2.60	3.68	3.78	3.60	4.05
18	2.80	3.43	3.25	3.10	2.80	4.75	2.63	2.60	3.65	3.80	3.63	3.90
19	2.93	3.35	3.50	3.20	2.80	4.75	2.60	2.55	3.68	3.75	3.63	3.90
20	3.93	3.35	5.95	3.55	2.80	3.98	2.60	2.55	3.60	3.70	3.65	3.78
21	6.30	3.25	7.20	3.60	2.80	3.63	2.63	2.50	3.60	3.70	3.70	3.70
22	4.65	3.75	5.70	3.60	2.80	3.30	2.70	2.55	3.58	3.70	3.63	3.60
23	3.90	5.98	4.90	4.23	2.80	3.20	2.83	2.60	3.58	3.70	3.60	3.80
24	3.55	5.30	4.43	4.40	2.80	3.15	4.28	2.60	3.60	3.78	3.68	3.75
25	3.25	4.63	4.17	4.10	2.80	3.08	3.33	2.60	3.55	3.75	3.70	3.70
26	3.03	4.15	4.00	3.75	2.80	3.00	3.23	2.60	3.60	3.85	4.65	3.75
27	3.00	3.90	4.00	3.63	2.80	2.93	3.00	2.58	3.60	3.90	7.00	3.80
28	3.00	3.80	3.90	3.50	2.80	2.90	2.93	2.60	3.63	3.80	5.25	3.78
29	3.50	.....	3.90	3.43	2.80	2.90	2.83	2.63	3.73	3.75	5.35	3.78
30	4.00	.....	3.85	3.33	2.80	2.90	3.08	2.60	3.95	3.73	4.45	3.73
31	4.00	.....	3.80	.....	2.75	.....	2.80	2.63	.....	3.70	.....	3.73

SOUTH BRANCH OF SHENANDOAH RIVER AT FRONT ROYAL, VIRGINIA.

This station was established by Arthur P. Davis on June 26, 1899. It is described in Water-Supply Paper No. 35, page 89, where will also be found record of discharge measurement made in 1899. During 1900 the following measurements were made by E. G. Paul:

February 14: Gage height, 5.75 feet: discharge, 1,955 second-feet.
June 19: Gage height, 7.90 feet; discharge, 5,703 second-feet.

Daily gage height, in feet, of South Branch of Shenandoah River at Front Royal, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.55	4.95	6.40	5.90	5.30	4.95	4.80	4.60	4.10	4.30	4.50	5.30
2	5.55	4.80	10.65	5.75	5.25	4.85	4.70	4.55	4.10	4.25	4.50	5.35
3	5.60	5.00	8.80	5.70	5.15	4.80	4.60	4.45	4.10	4.25	4.40	5.15
4	5.55	5.60	7.55	5.60	5.10	4.80	4.60	4.40	4.10	4.25	4.45	5.55
5	5.50	5.20	6.90	5.50	5.00	4.80	4.60	4.40	4.10	4.40	4.55	5.80
6	5.35	5.65	6.60	5.40	5.00	4.80	4.50	4.30	4.00	4.30	4.60	7.60
7	5.10	5.40	6.35	5.40	5.00	4.70	4.50	4.30	4.00	4.40	4.50	6.75
8	5.05	5.00	6.20	5.30	4.90	4.70	4.50	4.30	4.00	4.40	4.50	6.10
9	4.95	5.00	6.10	5.20	4.80	4.70	4.40	4.20	4.00	4.30	4.50	5.95
10	5.05	.....	6.00	5.20	4.80	4.60	4.40	4.20	4.00	4.40	4.40	5.85
11	4.85	5.00	5.90	5.20	4.80	4.60	4.40	4.20	4.00	4.45	4.45	5.60
12	4.95	4.95	5.80	5.10	4.70	4.50	4.40	4.20	3.90	4.45	4.45	5.45
13	5.00	5.10	5.70	5.10	4.70	4.40	4.30	4.20	3.90	4.40	4.40	5.15
14	5.60	6.35	5.60	5.10	4.70	4.70	4.30	4.20	3.90	4.25	4.40	5.10
15	5.65	7.20	5.60	5.10	4.70	5.70	4.30	4.10	4.30	4.25	4.40	5.00
16	5.00	6.50	5.50	5.10	4.70	6.25	4.30	4.10	4.65	4.30	4.30	4.90
17	4.80	6.20	5.50	5.00	4.60	7.25	4.90	4.10	4.95	4.30	4.30	4.85
18	4.80	5.95	5.50	5.00	4.50	7.95	4.20	4.00	4.65	4.40	4.30	4.80
19	5.00	5.70	5.65	5.00	4.70	7.65	4.20	4.00	4.15	4.40	4.30	4.75
20	7.20	5.55	6.55	5.40	5.30	6.85	4.20	4.00	4.15	4.30	4.30	4.70
21	10.70	5.45	9.55	5.75	6.75	6.20	4.55	4.10	4.15	4.25	4.30	4.60
22	8.35	6.25	8.35	5.90	5.55	5.80	4.90	4.20	4.15	5.05	4.40	4.60
23	7.15	8.90	7.50	6.55	5.35	5.30	4.85	4.25	4.10	6.25	4.85	4.60
24	6.50	8.65	6.60	6.70	5.25	5.35	4.65	4.30	4.20	6.95	4.95	4.60
25	6.15	7.35	6.55	6.25	5.20	5.20	4.85	4.30	4.30	6.75	5.65	4.60
26	5.80	6.85	6.45	6.30	5.35	5.10	4.95	4.30	4.35	5.60	6.65	4.60
27	5.60	6.56	6.30	5.75	5.05	5.10	5.00	4.25	4.15	6.35	8.45	4.50
28	5.55	6.20	6.25	5.55	4.90	5.20	4.90	4.20	4.05	5.05	7.30	4.50
29	5.55	.....	6.15	5.40	4.85	5.05	4.85	4.20	4.00	4.65	6.35	4.50
30	5.50	.....	6.00	5.40	4.80	4.90	4.80	4.10	4.20	4.55	5.85	4.50
31	5.20	.....	5.95	.....	5.45	.....	4.70	4.10	.....	4.50	.....	4.50

SHENANDOAH RIVER AT MILLVILLE, WEST VIRGINIA.

This station, which was established April 15, 1895, is 4 miles above the mouth of Shenandoah River. It is described in Water-Supply Paper No. 35, pages 90 and 91. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 96. During 1900 the following measurements were made by E. G. Paul:

February 24: Gage height, 5.9 feet; discharge, 12,985 second-feet.
June 19: Gage height, 4.5 feet; discharge, 9,132 second-feet.
September 15: Gage height, 0.4 foot; discharge, 500 second-feet.

Daily gage height, in feet, of Shenandoah River at Millville, West Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.25	2.10	3.00	2.55	1.80	1.50	1.30	1.15	0.60	0.60	0.80	2.00
2	1.30	1.20	4.80	2.50	1.75	1.50	1.25	1.00	.60	.70	.80	1.70
3	1.20	1.60	6.50	2.40	1.70	1.30	1.25	1.05	.60	.70	.80	1.50
4	1.15	1.55	4.80	2.25	1.60	1.30	1.20	1.00	.60	.70	.90	1.60
5	1.20	2.00	3.90	2.20	1.60	1.30	1.20	.90	.55	.60	.90	2.25
6	1.30	2.00	3.40	2.10	1.50	1.25	1.30	.85	.50	.55	.90	4.80
7	1.30	1.50	2.90	2.00	1.50	1.15	1.10	.80	.50	.50	.85	3.60
8	1.30	1.40	2.80	1.90	1.40	1.10	1.00	.75	.45	.50	.90	2.80
9	1.20	1.40	2.70	1.85	1.40	1.95	.90	.70	.45	.75	.85	3.40
10	1.15	1.40	2.60	1.80	1.40	1.00	.85	.70	.45	.60	.80	2.20
11	1.20	1.40	2.50	1.70	1.30	.95	.80	.70	.45	.55	.80	1.90
12	1.10	1.40	2.40	1.70	1.30	.90	.80	.65	.40	.50	.80	1.75
13	1.30	1.50	2.30	1.70	1.30	1.00	.80	.70	.40	.50	.80	1.60
14	1.40	1.90	2.20	1.70	1.20	.90	.75	.60	.40	.70	.75	1.50
15	1.50	3.80	2.10	1.70	1.20	1.10	.75	.60	.40	.90	.75	1.40
16	1.30	3.30	2.10	1.60	1.15	1.30	.70	.55	.50	1.10	.75	1.35
17	1.20	2.80	2.10	1.60	1.10	2.30	.70	.60	.60	.90	.70	1.30
18	1.15	2.50	2.00	1.55	1.10	2.70	.60	.60	.55	.80	.70	1.20
19	1.20	2.30	2.00	1.60	1.20	4.50	.60	.60	1.10	.80	.65	1.15
20	1.80	2.20	3.30	1.65	1.10	3.70	1.20	.60	.80	.70	.65	1.15
21	6.00	2.50	5.95	2.10	1.90	3.00	.80	.65	.70	.60	.60	1.10
22	5.90	2.45	6.20	2.40	1.90	2.60	1.00	.60	.60	.55	.65	1.00
23	4.20	4.35	4.70	2.55	1.70	2.10	1.10	.55	.55	.50	.70	1.00
24	3.30	5.90	3.90	3.00	1.60	1.90	1.40	.60	.55	.65	.70	1.00
25	2.80	4.50	3.45	3.00	1.40	1.70	2.50	.60	.50	.80	.70	1.00
26	2.50	3.80	3.15	2.70	1.25	1.55	2.80	.55	.50	2.10	1.10	1.00
27	2.25	3.40	3.00	2.50	1.50	1.45	1.70	.65	.45	.60	2.10	.95
28	2.00	2.80	2.95	2.30	1.50	1.40	1.50	.70	.50	1.25	4.50	.90
29	1.90	.....	2.80	2.15	1.50	1.35	1.30	.60	.55	1.10	3.15	.90
30	1.80	.....	2.70	2.00	1.40	1.30	1.30	.60	.50	.95	2.45	.90
31	1.85	.....	2.60	.....	1.30	.....	1.20	.60	.....	.90	.....	.90

POTOMAC RIVER AT POINT OF ROCKS, MARYLAND.

This station was established February 17, 1895, at the tollbridge over the Potomac River at Point of Rocks. It has been described and results of measurements have been given in the various Annual Reports and in the Water-Supply and Irrigation Papers containing reports of the operations at river stations. More or less difficulty has been experienced with the wire gage, due to its stretching, and no record of this lengthening has been noted. A thorough study of the changes of the gage have been made in this office, based on measurements and on a study of the average depth of soundings, with the result that it has been found necessary to modify the gage heights in order to refer them to a common datum. This has also necessitated a revision of the rating table. In some cases it has been impossible to reduce the measurements to the known datum, and it has therefore been thought best to discard them and to publish here only such gage heights and discharge measurements as could be reduced to a common datum and on which reliance can be placed as giving a correct estimate of the discharge.

As originally placed the gage was located in the third span of the bridge from the north shore. The next year (1896) the wire became rusted and broke frequently, and a new wire gage was placed in the east side of the first span of the bridge, but it was referred to a different datum. During 1897 there was a further change in the length

of the gage, which was not recorded, and therefore it has been necessary to discard the records during those two years—that is, 1896 and 1897.

On January 25, 1898, the gage wire was compared with the bench mark, and the observations since that date have been referred to this datum. The bench mark to which the gage has been referred is a copper bolt in a large capstone on the lower wing wall of the north abutment, about 10 feet from the north end of the first iron truss and 41.30 feet above the datum of the gage. The length of the cable of the wire gage is 44.22 feet. The measurements of 1895 are considered correct within themselves, but there was a difference between the datum of that gage and that of the present standard of 0.4 foot, making it necessary to deduct that amount from the gage readings of 1895 in order to reduce them to the present datum. Tables of the corrected gage heights and of the discharge measurements computed from them are published herewith.

The flood discharge of February 23, 1897, is also considered correct, and is given in the table of discharge measurements. There is no change in the published discharge measurements or the gage heights for 1898, 1899, and 1900, but they are reproduced here in order to bring together all of the records that could be reduced to one standard.

Discharge measurements of Potomac River at Point of Rocks, Maryland.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1895.	*Feet.*	*Sec.-ft.*	1898.	*Feet.*	*Sec.-ft.*
March 25	3.05	10,524	January 25	6.50	33,344
April 5	3.42	14,032	August 19	3.30	14,309
April 13	4.27	17,516	October 3	.65	1,939
April 23	2.10	7,371	1899.		
May 1	4.35	21,073	January 28	3.80	17,330
May 7	3.10	12,484	May 20	8.15	45,986
May 17	2.35	8,918	September 5	.80	2,360
May 28	2.45	9,189	October 29	.50	1,628
June 3	1.53	4,536	1900.		
June 17	1.30	4,233	June 28	1.50	5,212
July 10	1.50	4,695	October 2	.30	1,259
November 6	.40	1,202			
1897.					
February 23	21.70	109,913			

Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1895.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.10	3.10	3.30	1.80	2.00	1.00	0.60	0.30	0.40	0.40
2	.....	9.70	3.00	5.90	1.70	2.70	.90	.70	.30	.40	.50
3	.....	10.60	2.90	5.80	1.50	2.30	.80	.90	.30	.30	.50
4	.....	9.60	3.60	5.40	1.40	2.10	.80	.70	.30	.30	.50
5	.....	7.10	3.50	4.40	1.40	1.90	.90	.60	.30	.30	.50
6	.....	5.60	3.00	3.70	1.40	1.70	.80	.60	.30	.40	.60
7	.....	4.80	2.70	3.10	1.20	1.50	.80	.60	.30	.30	.80
8	.....	4.30	2.60	2.70	.80	1.50	.80	.50	.30	.30	.80
9	.....	4.10	3.00	2.70	1.30	1.70	1.10	.50	.30	.30	.60
10	.....	4.10	10.80	2.80	1.20	1.60	1.00	.60	.30	.40	.50
11	.....	4.00	7.90	2.80	1.10	1.50	.90	.50	.30	.40	.50
12	.....	3.60	5.80	2.70	1.10	1.50	.80	.50	.40	.50	.50
13	.....	3.60	4.50	2.70	1.20	1.30	.80	.50	.20	.40	.60
14	.....	3.60	3.80	2.80	1.20	1.20	.70	.50	.20	.40	1.60
15	.....	4.70	3.50	3.00	1.50	1.10	.70	.50	.30	.40	.60
16	.....	5.90	3.40	2.60	1.30	1.00	.60	.50	.30	.40	.50
17	1.60	8.10	3.30	2.40	1.20	1.00	.60	.40	.30	.40	.40
18	1.60	6.90	3.00	2.20	1.10	1.00	.60	.40	.30	.40	.40
19	1.60	5.40	2.70	2.20	1.10	1.10	.60	.50	.30	.40	.30
20	1.60	4.90	2.60	2.40	1.00	1.00	.60	.50	.30	.40	.30
21	1.70	4.10	2.40	2.30	.90	1.00	.60	.40	.20	.40	.30
22	1.80	3.80	2.20	2.40	1.00	1.00	.50	.40	.20	.40	.60
23	2.00	3.40	2.10	2.80	1.00	1.10	.50	.40	.30	.40	.60
24	2.00	3.20	2.00	3.80	.90	.90	.50	.50	.30	.40	1.30
25	2.00	3.00	2.00	3.30	.80	.90	.40	.50	.30	.40	1.30
26	2.10	2.90	1.90	2.60	.80	1.00	.40	.40	.30	.40	1.20
27	2.90	3.00	1.80	2.50	1.20	1.20	.40	.40	.30	.40	1.30
28	3.60	3.80	1.80	2.40	2.10	1.30	.40	.40	.30	.50	1.40
29	.....	3.20	1.80	2.40	1.60	1.20	.40	.40	.30	.50	.90
30	.....	4.30	2.20	2.20	1.50	1.10	.50	.30	.30	.40	.90
31	.....	3.50	.....	2.00	.....	1.10	.50	.....	.30	.....	1.30

Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	2.80	1.90	6.10	2.60	2.20	0.90	1.50	1.20	0.70	2.70	2.10
2	2.90	1.70	1.80	5.20	2.40	2.00	.80	1.70	1.10	.70	2.50	2.10
3	3.00	2.00	1.70	4.60	2.20	1.80	.80	1.40	1.10	.60	2.30	2.00
4	3.20	1.90	1.70	4.10	2.00	1.70	.70	1.20	1.00	.70	2.20	2.50
5	3.20	1.90	1.60	3.80	1.90	1.60	.70	2.20	1.00	.80	2.00	5.10
6	3.30	2.00	1.60	3.60	1.80	1.40	.70	7.20	1.00	.80	1.80	9.20
7	3.20	2.00	1.60	3.20	2.20	1.30	.70	6.10	1.00	1.00	1.80	6.10
8	2.90	1.90	1.50	2.90	5.40	1.30	.80	3.70	1.00	1.10	1.70	4.50
9	3.00	1.90	1.50	2.40	11.05	1.20	.70	3.90	1.00	1.00	1.60	3.60
10	3.20	1.80	1.40	2.50	9.60	1.20	.70	5.60	.90	1.00	1.60	3.00
11	3.90	1.80	1.40	2.50	6.50	1.10	.70	14.00	.90	.90	2.00	2.60
12	5.80	1.90	1.50	2.40	5.20	1.10	.60	16.05	.90	.90	1.80	2.40
13	5.70	2.00	1.50	2.40	4.20	1.10	.50	9.50	.80	1.40	1.80	2.20
14	5.30	1.90	1.60	2.50	3.70	1.30	.50	8.00	.80	1.20	2.00	2.20
15	5.50	1.90	1.60	2.50	3.10	1.30	.50	7.20	.80	1.00	2.00	2.00
16	6.70	2.00	1.70	4.00	3.00	1.30	.50	6.10	.80	.80	1.80	1.80
17	8.00	2.00	1.70	9.00	3.20	1.30	.50	5.20	.80	.80	1.80	1.80
18	6.70	1.80	2.00	6.70	4.60	1.20	.50	4.30	.80	.80	1.80	2.00
19	5.60	1.70	5.80	5.10	4.40	1.50	.70	3.30	.80	1.40	2.20	2.10
20	4.90	1.70	4.60	4.20	3.50	1.40	.70	3.10	.70	9.00	3.00	2.20
21	4.70	2.80	3.50	3.50	2.30	1.30	.90	3.00	.70	5.40	3.60	2.60
22	4.60	3.80	3.50	3.20	2.90	1.30	.90	3.80	.70	5.35	3.30	3.30
23	5.00	4.10	6.60	2.90	3.10	1.30	1.10	2.80	.70	13.10	3.20	4.70
24	9.40	3.40	6.20	2.60	3.90	1.20	.90	2.30	.70	10.10	3.10	6.20
25	8.40	2.90	6.40	2.60	5.10	1.10	.80	2.00	.70	5.90	3.00	6.90
26	5.10	2.60	10.50	2.60	5.60	1.10	.90	1.80	.70	4.50	2.70	5.30
27	5.00	2.30	7.20	2.50	4.10	1.00	1.20	1.50	.90	3.80	2.60	4.30
28	5.10	2.10	5.30	3.30	3.40	1.00	1.00	1.50	.80	3.60	2.40	3.70
29	5.10	.....	4.40	3.00	3.00	.90	1.20	1.40	.70	3.40	2.20	3.20
30	3.60	.....	4.30	2.80	2.80	.90	1.40	1.30	.70	3.00	2.10	3.00
31	3.40	.....	6.20	.....	2.40	.....	1.70	1.30	.....	2.80	.....	2.70

Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.40	11.90	5.30	1.60	2.00	1.00	0.70	0.90	0.70	0.80	0.80
2	3.40	2.00	9.20	4.50	1.60	2.40	1.00	.70	.90	.60	1.50	.80
3	2.90	2.10	8.20	4.00	2.10	3.80	1.10	.70	.80	.60	2.50	.80
4	2.70	2.10	7.60	3.60	1.70	2.60	1.00	.90	.80	.60	2.00	.80
5	2.30	2.00	8.50	3.30	1.70	2.10	.90	1.00	.80	.60	1.80	.80
6	4.10	2.00	16.55	3.00	2.10	1.80	1.00	1.10	.70	.60	1.40	.70
7	6.90	2.00	12.90	2.80	2.00	1.60	2.00	1.10	.70	.70	1.40	.70
8	8.10	2.30	10.00	3.00	1.90	1.50	1.00	1.10	.60	.70	1.30	.70
9	6.80	2.30	8.10	3.50	1.00	1.40	1.00	1.00	.60	.70	1.20	.70
10	5.40	3.60	6.00	3.40	2.40	1.70	.90	1.00	.60	.60	1.00	.70
11	4.60	4.20	5.80	4.20	4.50	1.80	.90	.90	.60	.60	.90	.70
12	3.90	4.20	5.60	4.50	3.80	1.70	.80	.80	.80	.60	.90	.80
13	3.60	4.00	5.00	3.40	3.40	1.70	.80	.60	1.20	.60	.80	.80
14	3.40	3.90	4.80	3.20	3.20	1.60	.80	.60	1.10	.50	.80	1.20
15	3.40	3.80	4.50	3.00	2.80	1.50	.90	.60	1.00	.50	.80	3.00
16	4.00	4.00	4.60	2.80	2.50	1.50	1.10	.70	.90	.50	.80	2.10
17	5.70	4.50	4.70	2.70	2.30	1.40	.90	.70	.80	.50	.80	1.70
18	5.20	5.00	4.40	2.60	2.40	1.40	.70	.60	.70	.50	.70	1.50
19	4.70	5.20	5.20	2.50	8.55	1.30	.70	.60	.70	.50	.70	1.60
20	4.40	5.40	5.40	2.40	6.30	1.30	.70	.60	.90	.50	.70	1.50
21	4.00	6.00	5.30	2.20	5.00	1.20	.70	.60	.70	.50	.70	1.30
22	3.50	8.50	4.70	2.10	3.60	1.20	.70	.50	.80	.50	.70	1.10
23	3.30	14.80	4.20	2.00	3.00	1.10	.70	.50	.90	.50	.80	1.00
24	3.20	13.70	4.00	2.00	2.70	1.10	.60	.50	.90	.50	.80	1.20
25	3.30	9.00	3.90	2.00	2.40	1.00	.60	.50	.90	.50	.90	1.80
26	4.80	6.00	3.70	1.90	2.10	1.00	.60	.50	1.00	.50	.90	2.10
27	4.70	9.25	3.50	1.90	2.00	1.00	.60	1.20	.80	.50	.80	1.60
28	3.90	13.90	3.40	1.80	1.80	1.20	.60	1.10	.70	.50	.80	1.50
29	3.20	.....	3.60	1.70	1.70	1.10	.50	1.10	.70	.50	.80	1.60
30	2.80	.....	8.60	1.70	1.70	1.00	.80	1.00	.80	.50	.80	1.60
31	2.60	.....	7.00	.....	1.80	.....	.80	1.00	.....	.60	.....	1.60

Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.00	3.50	4.80	1.90	1.30	1.20	1.20	0.70	0.30	0.50	2.40
2	1.50	1.60	4.50	3.80	1.70	1.30	1.10	1.10	.70	.30	.50	1.90
3	1.40	2.00	6.60	3.40	1.60	1.30	1.00	1.00	.60	.30	.50	1.60
4	1.50	2.10	5.90	3.10	1.50	1.40	1.00	.90	.60	.30	.50	1.60
5	1.50	2.20	4.40	2.80	1.50	1.60	.90	.90	.50	.30	.50	2.00
6	1.40	1.90	4.00	2.70	1.40	1.60	1.30	.80	.60	.30	.40	4.10
7	1.40	1.80	3.60	2.60	1.40	1.50	1.00	.80	.50	.30	.40	5.90
8	1.30	1.50	3.90	2.50	1.30	1.40	.90	.70	.40	.30	.40	3.70
9	1.30	1.80	4.50	2.40	1.30	1.40	.80	.60	.40	.30	.50	3.00
10	1.20	2.30	4.00	2.30	1.30	1.30	.70	.60	.30	.30	.60	2.50
11	1.30	3.00	3.60	2.10	1.20	1.20	.60	.50	.40	.30	.50	2.10
12	1.40	2.50	3.20	2.10	1.20	1.10	.60	.50	.30	.30	.40	1.80
13	1.40	3.00	2.90	2.00	1.10	1.00	.50	.40	.30	.30	.40	1.60
14	1.50	4.50	2.80	1.90	1.10	.90	.50	.40	.40	.30	.40	1.50
15	1.80	5.30	2.70	1.90	1.10	1.30	.50	.40	.40	.90	.40	1.40
16	2.10	4.50	2.60	1.80	1.10	1.00	.40	.40	.40	.50	.40	1.40
17	1.90	3.80	2.40	1.80	1.00	1.80	.40	.40	.30	.40	.40	1.50
18	1.70	3.10	2.30	1.70	1.00	2.80	.40	.40	.30	.40	.30	1.20
19	1.60	2.60	2.40	1.70	1.20	8.50	.50	.40	.30	.30	.20	1.10
20	2.20	2.30	2.60	1.60	1.30	6.20	1.40	.40	.30	.30	.20	1.10
21	3.60	1.90	5.80	1.70	1.80	4.60	1.00	.40	.30	.30	.30	1.00
22	6.80	3.00	8.70	2.20	1.90	3.60	.90	.40	.30	.50	.40	.90
23	5.50	6.90	6.60	2.50	2.00	2.70	.80	.40	.30	.40	.40	.90
24	4.00	7.10	5.40	2.80	1.70	2.30	1.80	.40	.30	.40	.40	.80
25	3.30	5.60	5.00	3.00	1.50	2.10	1.60	.50	.30	.40	.40	.80
26	2.80	3.90	4.50	2.80	1.40	2.00	2.00	.60	.30	.40	1.20	.80
27	2.50	3.30	4.10	2.50	1.40	1.80	1.40	.70	.30	.50	3.30	.80
28	2.10	3.00	3.70	2.30	1.40	1.50	1.20	.90	.20	.50	8.20	.80
29	1.80	.....	3.50	2.10	1.30	1.40	1.00	.90	.30	.50	5.40	.80
30	1.30	.....	3.30	2.00	1.20	1.30	1.30	.80	.30	.50	3.20	.80
31	1.20	.....	3.20	.....	1.30	.....	1.30	.80	.....	.50	.....	.80

MONOCACY RIVER NEAR FREDERICK, MARYLAND.

This station was established August 4, 1896, by E. G. Paul, at the county bridge on the turnpike 4 miles northeast of Frederick, on the road leading from Frederick to Mount Pleasant, Maryland, about 2,000 feet above the mouth of Israel Creek and 3,000 feet below the mouth of Tuscarora Creek. It is described in Water-Supply Paper No. 35, page 93. Records of discharge measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 98. During 1900 the following measurements were made by Mr. Paul:

June 29: Gage height, 4.10 feet; discharge, 191 second-feet.
September 20: Gage height, 3.80 feet; discharge, 88 second-feet.

Daily gage height, in feet, of Monocacy River near Frederick, Maryland, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.40	5.10	13.45	5.40	4.70	4.40	4.00	4.00	3.90	3.90	3.70	5.20
2	5.40	5.10	12.00	5.70	4.70	4.40	4.00	3.90	3.80	3.80	3.70	4.30
3	5.40	5.10	9.50	5.50	4.70	4.40	3.90	3.90	3.80	3.80	3.70	4.30
4	5.20	5.10	8.20	5.50	4.90	4.40	3.90	3.80	3.70	3.80	4.10	7.20
5	5.00	5.20	7.30	5.50	4.80	4.40	3.90	3.70	3.70	3.80	4.10	12.10
6	4.90	5.10	7.10	5.40	4.60	4.30	3.90	3.70	3.70	3.70	4.00	6.00
7	4.80	5.30	8.00	5.30	4.50	4.20	3.80	3.70	3.70	3.70	4.00	5.50
8	4.50	6.90	7.50	5.20	4.40	4.20	3.80	3.70	3.70	3.70	4.00	5.20
9	4.50	7.55	6.50	5.10	4.40	4.20	3.70	3.70	3.70	3.70	3.90	4.90
10	4.90	6.90	6.30	5.10	4.40	4.10	3.70	3.70	3.60	3.70	3.90	4.50
11	5.00	5.30	6.30	5.00	4.40	4.10	3.70	3.60	3.60	3.70	3.90	4.30
12	10.20	5.50	5.90	5.00	4.40	4.10	3.70	3.60	3.60	3.70	3.90	4.20
13	9.20	15.10	5.70	5.00	4.30	4.10	3.70	3.50	3.60	3.70	3.90	4.00
14	5.40	12.85	5.60	5.00	4.30	4.10	3.70	3.50	3.60	3.90	3.90	4.00
15	4.90	7.00	5.50	5.00	4.30	4.40	3.70	3.50	3.60	4.10	3.90	4.00
16	4.80	6.50	5.40	4.90	4.30	4.80	3.60	3.50	3.90	4.10	3.90	4.00
17	4.60	5.90	5.40	4.90	4.30	5.00	3.60	3.60	3.90	4.10	3.90	4.00
18	4.60	5.90	5.40	5.10	4.30	5.80	3.60	3.90	3.90	3.90	3.80	4.00
19	4.90	5.80	5.40	5.20	6.50	6.00	3.70	3.80	3.90	3.80	3.80	3.90
20	9.00	5.50	13.50	5.10	7.00	5.10	4.60	3.80	3.80	3.70	3.80	3.90
21	9.50	5.50	10.20	5.00	6.50	4.90	4.60	3.80	3.80	3.70	3.80	3.90
22	7.05	17.15	9.10	5.00	5.90	4.50	3.80	4.80	3.70	3.70	3.80	4.00
23	6.50	15.00	8.20	5.50	4.90	4.40	4.10	4.70	3.60	3.80	3.90	4.00
24	6.00	10.50	6.50	5.60	4.80	4.20	5.50	4.10	3.50	3.80	3.90	4.10
25	5.70	8.50	6.10	5.40	4.70	4.20	4.80	4.70	3.50	3.80	3.90	4.10
26	5.50	7.10	6.00	4.90	4.60	4.20	4.20	4.00	3.50	3.70	9.20	4.10
27	5.10	6.50	5.90	4.80	4.50	4.20	4.20	3.90	3.50	3.70	7.30	4.10
28	4.90	6.50	5.70	4.80	4.50	4.10	4.10	5.50	3.60	3.70	7.10	4.10
29	4.60	.....	5.50	4.80	4.50	4.10	4.00	5.30	3.70	3.70	6.90	4.00
30	4.50	.....	5.50	4.70	4.50	4.00	4.00	4.30	4.00	3.70	6.30	.....
31	4.50	.....	6.50	.....	4.50	.....	4.00	4.00	.....	3.70	.....	.....

ROCK CREEK AT ZOOLOGICAL PARK, DISTRICT OF COLUMBIA.

The first station on Rock Creek was established in 1892, at the request of the Commissioners of the District of Columbia. On January 18, 1897, a new station was established on the bridge of the Zoological Park. This bridge was rebuilt in November, 1900, and the gage was destroyed. A new station will be established in 1901. During 1900 one measurement was made by E. G. Paul, as follows:

April 24: Gage height, 2.75 feet; discharge, 77 second-feet.

Daily gage height, in feet, of Rock Creek at Zoological Park, District of Columbia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.45	2.43	3.30	2.75	2.60	2.45	2.35	2.35	2.15	2.40	2.10
2	2.43	2.43	3.25	2.70	2.60	2.73	2.35	2.28	2.13	2.30	2.15
3	2.43	2.38	2.88	2.70	2.60	2.60	2.35	2.30	2.10	2.20	2.15
4	2.40	2.40	2.78	2.70	2.60	2.55	2.40	2.28	2.10	2.20	2.28
5	2.38	3.03	2.75	2.68	2.60	2.50	2.38	2.25	2.10	2.20	2.35
6	2.40	2.60	2.80	2.65	2.55	2.45	2.38	2.25	2.10	2.20	2.28
7	2.40	2.53	2.85	2.65	2.55	2.45	2.38	2.23	2.10	2.15	2.25
8	2.40	2.83	2.73	2.65	2.55	2.58	2.35	2.20	2.10	2.25	2.40
9	2.40	2.95	2.70	2.63	2.60	2.45	2.33	2.20	2.10	2.25	2.48
10	2.40	2.68	2.68	2.60	2.63	2.45	2.30	2.20	2.10	2.20	2.43
11	2.43	2.60	2.65	2.60	2.58	2.40	2.30	2.20	2.10	2.20	.....
12	3.60	2.68	2.70	2.80	2.55	2.35	2.30	2.15	2.10	2.20	.....
13	3.03	3.88	2.70	2.75	2.53	2.45	2.30	2.18	2.10	2.23	.....
14	2.88	3.00	2.70	2.68	2.50	2.48	2.30	2.15	2.10	2.35	.....
15	2.58	2.80	2.68	2.65	2.50	2.68	2.30	2.15	2.13	2.35	.....
16	2.53	2.75	2.70	2.65	2.50	2.65	2.30	2.15	2.65	2.30	.....
17	2.80	2.70	2.78	2.70	2.50	4.30	2.30	2.15	2.40	2.25	.....
18	2.80	2.70	2.80	2.70	2.50	3.45	2.30	2.15	2.20	2.20	.....
19	2.83	2.70	2.80	3.10	2.90	2.78	2.30	2.10	2.17	2.20	.....
20	3.08	2.78	3.75	2.80	2.78	2.70	2.40	2.10	2.15	2.20	.....
21	3.13	2.73	3.18	2.73	2.55	2.58	2.40	2.18	2.15	2.20	.....
22	2.88	5.20	2.85	2.80	2.50	2.55	2.48	2.28	2.15	2.20	.....
23	2.80	3.35	2.80	2.80	2.50	2.50	2.40	2.23	2.15	2.20	.....
24	2.75	2.90	2.78	2.75	2.45	2.50	2.73	2.25	2.15	2.25	.....
25	2.68	2.90	2.73	2.70	2.50	2.50	2.48	2.48	2.15	2.23	.....
26	2.60	3.08	2.75	2.70	2.50	2.48	2.35	2.28	2.15	2.18	.....
27	2.58	3.05	2.80	2.70	2.45	2.48	2.38	2.20	2.15	2.15	.....
28	2.68	2.78	2.80	2.65	2.45	2.43	2.30	2.20	2.45	2.15	.....
29	2.48	.....	2.80	2.60	2.45	2.35	2.30	2.20	2.40	2.10	.....
30	2.48	.....	2.80	2.60	2.45	2.35	2.30	2.20	2.60	2.10	.....
31	2.55	.....	2.80	.....	2.40	.....	2.50	2.15	.....	2.10	.....

APPOMATTOX RIVER AT MATTOAX, VIRGINIA.

This station was established in August, 1900, at the crossing of the Southern Railway, 27 miles southwest of Richmond. The gage rod, which is on the guard rail of the bridge, is laid off to feet and tenths, graduations being indicated by brass nails. The zero of the rod is 58.1 feet from the west end of the bridge, on the upstream side. The outer rim of the pulley is 0.9 foot from the zero of the rod; the distance from the end of the weight to the pointer on the wire rope is 48.75 feet. When the gage reading is 1 foot the water level is 45.6 feet below the top surface of the upper chord of the bridge, upstream side, and at the zero of the gage.

The river here is straight for a considerable distance above the station, but there is an abrupt bend about 100 feet below the bridge. The river is very narrow, and at the low stage at which the gage was placed the current velocity is not very well distributed, there being practically no current for several feet next to the west bank. It was possible, however, to secure a good gaging, and old residents stated that the river was at the lowest stage it had reached in fourteen years. The Mattoax railroad station is located on the west bank of the river, and J. C. Carter, the station agent, is the observer. During 1900 the following measurements were made by E. W. Myers:

August 25: Gage height, 1 foot; discharge, 196 second-feet.
November 1: Gage height, 0.85 foot; discharge, 177 second-feet.

Daily gage height, in feet, of Appomattox River at Mattoax, Virginia, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.25	0.73	0.80	1.10	17		3.75	0.90	1.00	1.00
2		.50	.68	.90	1.00	18		2.25	.85	.86	.75
3		.35	.88	1.40	.99	19		1.00	.85	.99	1.75
4		.33	.98	2.05	1.70	20		.78	.75	.96	1.50
5		.38	1.03	2.90	5.05	21		.60	.70	.93	1.45
6		.05	.98	2.00	6.50	22		.60	.65	.99	1.00
7		.13	.95	1.40	3.10	23		.60	.65	1.05	1.42
8		.15	.83	1.20	2.20	24		.73	.70	.94	3.00
9		.15	.88	1.10	1.90	25		.90	.80	.90	3.92
10		.17	1.68	1.15	1.55	26	0.50	.85	1.50	1.00	4.50
11		.17	1.20	1.10	1.04	27	.60	.60	1.05	1.90	3.00
12		.13	.85	1.00	1.15	28	.45	.65	.80	2.93	3.30
13		.03	.78	.95	1.25	29	.30	.55	.75	1.70	2.05
14		.06	.95	1.00	1.30	30	.55	.65	.80	1.20	2.00
15		.13	.95	.97	1.25	31	2.50		.85		2.35
16		2.53	1.00	.94	1.15						

NORTH (OF JAMES) RIVER AT GLASGOW, VIRGINIA.

This station, which was established August 21, 1895, by C. C. Babb and D. C. Humphreys, is at the East Glasgow county bridge about 1 mile above the mouth of the river. It is described in Water-Supply Paper No. 35, pages 95 and 96. Records of measurements made in 1899 will be found in the Twenty-first Annual Report, Part IV, page 107. During 1900 the following measurements were made by D. C. Humphreys:

March 5: Gage height, 2.18 feet; discharge, 1,234 second-feet.
June 26: Gage height, 1.45 feet; discharge, 600 second-feet.
August 4: Gage height, 0.71 foot; discharge, 252 second-feet.
December 19: Gage height, 1.08 feet; discharge, 398 second-feet.

Daily gage height, in feet, of North (of James) River at Glasgow, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.98	1.20	6.35	2.04	1.40	1.30	1.25	0.78	0.41	0.95	0.90	1.60
2	.92	1.05	4.10	1.98	1.40	1.30	1.15	.75	.40	.60	.85	1.55
3	.92	1.20	3.75	1.87	1.40	1.40	1.12	.70	.40	.55	.90	1.48
4	.95	1.25	3.25	1.82	1.35	1.30	1.10	.68	.41	.53	.95	a 2.89
5	.92	1.40	2.90	1.72	1.32	1.10	1.10	.60	.40	.50	.92	4.30
6	.90	1.40	2.65	1.65	1.30	1.00	1.05	.55	.40	.50	.90	3.85
7	.90	1.30	2.50	1.60	1.22	1.00	1.00	.52	.40	.50	.86	3.45
8	.89	2.20	2.30	1.52	1.20	1.00	.96	.51	.38	.50	.85	3.10
9	.90	2.00	2.28	1.50	1.20	1.00	.90	.51	.34	.50	.86	2.00
10	.90	1.90	2.50	1.45	1.20	1.00	.88	.50	.30	.50	.85	1.70
11	.98	1.78	2.10	1.45	1.15	.96	.85	.50	.30	.50	.85	1.58
12	1.45	1.62	2.06	1.42	1.10	1.00	.80	.50	.30	.50	.82	1.50
13	1.75	5.50	1.95	1.40	1.10	2.00	.75	.50	.40	.50	.80	1.40
14	1.52	4.45	1.75	1.35	1.10	1.45	.75	.50	.40	.48	.80	1.32
15	1.45	3.25	1.65	1.32	1.00	1.40	.72	.50	.50	.48	.78	1.28
16	1.35	2.85	1.85	1.28	1.00	4.40	.70	.50	2.40	.45	.80	1.20
17	1.35	2.40	2.03	1.25	1.00	4.00	.70	.50	1.10	.43	.78	1.10
18	1.36	a 2.20	1.90	1.30	.95	4.20	.72	.50	.60	.40	.80	1.08
19	2.50	2.00	1.90	2.60	2.52	3.30	.70	.48	.50	.48	.72	1.05
20	6.02	1.92	4.45	2.52	1.48	2.60	.75	.48	.40	.46	.70	1.02
21	4.35	1.95	5.60	a 2.00	1.45	2.30	.95	.50	.45	.45	.75	1.00
22	3.21	6.40	3.85	1.45	1.35	1.95	1.30	.50	.52	.46	.75	1.00
23	2.75	4.80	3.10	3.00	1.25	1.75	1.50	.48	.64	1.15	.76	1.00
24	2.15	3.45	2.82	2.65	1.28	1.50	1.10	.48	.60	3.60	.76	1.00
25	1.95	2.95	2.72	2.35	2.50	1.45	.85	.50	.60	2.55	.78	.98
26	1.76	2.80	2.50	2.15	2.00	1.40	1.15	.50	.60	1.45	6.35	.98
27	1.60	2.60	2.50	2.15	1.65	1.35	1.30	.52	.60	1.20	4.10	.95
28	1.50	2.35	2.38	2.10	1.50	1.25	1.05	.50	.52	1.15	2.90	.95
29	1.55		2.28	2.00	1.52	1.22	.95	.50	.50	1.00	2.25	.93
30	1.35		2.20	1.75	1.40	1.18	.88	.48	1.25	.95	1.84	.93
31	1.45		2.12		1.30		.88	.45		.90		.90

a Interpolated.

JAMES RIVER AT BUCHANAN, VIRGINIA.

This station, which was established August 18, 1895, by C. C. Babb and D. C. Humphreys, is located about 20 miles above the mouth of North River and a half mile above the mouth of Purgatory Creek. It is described in Water-Supply Paper No. 35, page 97. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 108. During 1900 the following measurements were made by D. C. Humphreys:

March 30: Gage height, 4.62 feet; discharge, 4,453 second-feet.
June 28: Gage height, 2.80 feet; discharge, 1,043 second-feet.
August 4: Gage height, 2.25 feet; discharge, 523 second-feet.
August 21: Gage height, 1.85 feet; discharge, 374 second-feet.
December 20: Gage height, 2.93 feet; discharge, 1,197 second-feet.

Daily gage height, in feet, of James River at Buchanan, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.20	2.40	6.80	4.40	3.10	2.85	2.70	2.40	1.90	2.20	2.50	4.20
2	2.20	2.40	9.25	4.15	3.00	2.75	2.60	2.30	1.90	2.20	2.50	3.80
3	2.20	2.30	6.80	4.00	2.90	3.30	2.60	2.30	1.90	2.20	2.80	3.70
4	2.10	2.35	5.50	3.90	2.85	3.05	2.60	2.25	2.15	2.20	3.45	6.05
5	2.10	2.55	4.90	3.80	2.80	2.90	2.50	2.10	2.90	2.10	3.55	9.30
6	2.10	2.50	4.55	3.70	2.80	2.80	2.50	2.10	2.80	2.10	3.25	6.25
7	2.00	2.50	4.40	3.60	2.70	2.70	2.40	2.00	2.20	2.10	2.95	5.35
8	2.00	2.95	4.40	3.50	2.65	2.70	2.40	2.00	1.95	2.10	2.80	4.95
9	2.00	3.65	4.60	3.35	2.50	2.60	2.30	2.00	1.80	2.10	2.70	4.75
10	2.10	3.80	4.35	3.20	2.55	2.50	2.20	1.90	1.80	2.10	2.60	4.40
11	2.40	3.50	4.20	3.10	2.50	2.50	2.20	1.90	1.80	2.10	2.60	3.95
12	3.10	3.35	4.05	3.00	2.50	2.50	2.30	1.90	1.70	2.10	2.50	3.80
13	4.20	6.85	3.90	3.00	2.50	3.10	2.30	1.90	1.70	2.10	2.50	3.65
14	3.55	9.20	3.75	3.00	2.40	2.80	2.20	1.90	1.70	2.10	2.50	3.50
15	3.15	6.10	3.60	2.90	2.40	2.80	2.20	1.90	2.10	2.35	2.50	3.35
16	2.95	5.50	3.60	2.80	2.40	4.60	2.10	1.90	3.15	2.70	2.40	3.20
17	2.80	4.55	3.50	2.80	2.30	6.30	2.00	1.80	3.35	2.60	2.40	3.10
18	2.80	4.30	3.40	2.95	2.30	6.90	2.00	1.80	2.60	2.45	2.40	3.10
19	3.75	3.60	3.50	4.15	2.25	6.00	2.00	1.80	2.35	2.30	2.40	3.00
20	9.30	3.35	9.50	4.90	2.90	4.65	2.00	1.70	2.20	2.20	2.30	2.90
21	8.15	3.30	10.30	4.65	2.85	4.15	2.00	1.70	2.10	2.20	2.30	2.90
22	5.60	8.00	7.40	4.70	2.65	3.90	2.00	1.70	2.10	2.30	2.30	2.90
23	4.55	7.45	5.95	5.45	2.50	3.25	2.00	1.80	2.10	2.95	2.30	2.80
24	3.95	6.40	5.20	4.85	2.65	3.05	2.00	1.80	2.20	10.45	2.65	3.05
25	3.50	5.60	4.95	4.40	4.50	3.00	2.10	1.80	2.10	5.65	4.25	3.10
26	3.30	4.80	4.85	4.25	4.00	2.90	3.10	1.80	2.10	4.10	18.60	3.00
27	3.20	4.35	4.80	3.85	3.45	2.80	3.20	1.90	2.10	2.90	12.20	3.00
28	2.75	4.15	4.90	3.70	3.20	2.70	3.15	1.90	2.20	2.70	6.85	2.90
29	2.55	.....	4.75	3.25	3.10	2.70	3.30	1.90	2.20	2.60	5.50	2.90
30	2.40	.....	4.60	3.15	3.00	2.70	2.75	1.90	2.20	2.60	4.85	2.80
31	2.40	.....	4.60	.....	3.00	.....	2.55	1.90	.....	2.60	.....	2.80

JAMES RIVER AT CARTERSVILLE, VIRGINIA.

This station, which was established January 1, 1899, by D. C. Humphreys, is located at the highway bridge crossing the James at Cartersville, a half mile from the railroad station and 50 miles above Richmond, Virginia. It is described in Water-Supply Paper No. 35, page 98, together with a number of other gages that have been installed on this river. Records of measurements for the year 1899

will be found in Paper No. 35, page 99. During 1900 the following measurements were made by D. C. Humphreys:

April 2: Gage height, 4.74 feet; discharge, 9,469 second-feet.
June 30: Gage height, 2.34 feet; discharge, 4,049 second-feet.
August 8: Gage height, 0.97 foot; discharge, 1,515 second-feet.
August 24: Gage height, 1.00 foot; discharge, 1,405 second-feet.
December 22: Gage height, 2.08 feet; discharge, 3,360 second-feet.

Daily gage height, in feet, of James River at Cartersville, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	2.10	7.80	4.95	3.50	2.65	2.30	1.75	0.90	1.00	1.85	6.65
2	2.20	1.75	15.65	4.73	3.30	2.48	2.00	1.53	.85	1.00	1.70	3.88
3	2.42	1.50	12.90	4.45	3.20	2.25	2.00	1.22	.70	1.00	1.70	3.33
4	2.42	2.25	9.50	4.20	3.00	3.55	1.95	1.30	.68	1.30	3.03	9.50
5	2.42	4.35	7.55	4.00	2.90	2.60	1.95	1.15	.65	1.20	2.30	11.30
6	2.42	4.00	6.40	3.75	2.80	2.25	1.85	1.10	.60	1.10	2.25	11.15
7	2.20	3.90	5.40	3.50	2.75	2.15	1.70	1.00	.60	1.05	2.15	8.00
8	2.10	3.15	5.10	3.40	2.75	2.00	1.55	.97	.50	1.05	2.00	5.90
9	1.85	2.90	5.10	3.10	2.50	2.30	1.50	.97	.50	1.05	1.90	5.55
10	1.80	2.90	5.05	3.00	2.60	2.15	1.48	.97	.60	1.05	1.72	5.05
11	1.60	3.40	4.80	3.10	2.60	1.95	1.47	.83	.60	1.02	1.67	4.00
12	3.65	3.45	4.40	3.50	2.50	1.65	1.30	.82	.50	1.00	1.55	3.52
13	4.40	7.30	4.00	3.30	2.35	5.00	1.27	.80	.25	.90	1.53	3.30
14	4.10	9.33	3.60	3.10	2.25	3.78	1.27	.74	.45	2.30	1.52	3.15
15	4.00	12.20	3.40	3.10	2.15	5.00	1.25	.73	.46	1.55	1.48	3.10
16	3.40	8.10	3.40	2.50	2.10	3.22	1.20	.70	2.50	1.20	1.47	2.90
17	2.80	6.05	3.40	2.50	2.00	10.60	1.10	.65	3.25	.90	1.47	2.50
18	2.40	5.30	3.60	11.15	1.95	10.20	1.10	.65	2.90	1.20	1.46	2.37
19	4.30	4.50	4.20	8.20	2.40	9.00	1.10	.82	2.17	1.25	1.44	2.34
20	13.08	4.00	6.00	7.50	2.75	7.50	1.21	.65	2.00	1.15	1.40	2.30
21	13.00	3.80	10.50	7.40	2.68	5.50	1.14	.70	1.30	1.10	1.38	2.20
22	11.60	8.30	11.75	8.50	2.58	4.48	1.07	.75	1.15	1.00	1.37	2.15
23	7.50	11.80	9.30	7.73	2.50	3.85	1.17	.95	1.00	1.20	1.34	2.00
24	6.10	11.25	7.00	7.50	2.40	3.50	1.80	1.00	1.05	1.70	1.30	2.00
25	5.00	9.05	6.00	6.40	3.40	3.20	1.70	1.25	1.03	10.90	1.30	2.75
26	4.20	7.00	5.50	5.50	3.35	3.25	1.40	.95	1.02	6.98	3.40	2.50
27	3.65	6.00	5.40	5.33	4.40	3.10	2.80	.80	1.00	4.70	15.15	2.22
28	3.25	5.10	5.30	4.57	3.60	2.65	2.80	1.15	1.00	3.70	18.10	2.10
29	3.00	.....	5.20	4.10	3.10	2.65	2.30	1.10	1.00	2.75	8.00	2.00
30	2.55	.....	5.00	3.80	2.95	2.35	2.25	.82	1.00	2.75	7.65	2.00
31	2.35	.....	5.30	.....	2.73	.....	1.95	1.03	.....	2.40	.....	2.00

JAMES RIVER AT HOLCOMB ROCK, VIRGINIA.

This station was established by the Willson Aluminum Company, of Holcomb Rock, Virginia, in 1899, in connection with measurements to determine the horsepower available at that point. During 1899 the records were fragmentary, but at the commencement of 1900 daily records were taken, which have been furnished to the Geological Survey through the courtesy of T. R. Ragland, general manager of the company. The gage consists of a copper float 8 by 8 by 8 inches, with a vertical rod 1½ inches square attached to it, the rod, which extends up through the power-house floor, being scaled to tenths of a foot. The copper float is inclosed in a 12-inch by 12-inch by 12-foot box, which rests solidly on the bottom of the river. The box is perforated, so that the water in it will always stand at the same level as the water in the river, while the float, being inclosed, is not in danger of being broken by floating timber. The fluctuations of the river are read directly from the rod, which moves up or down with the float as it responds to the variations in the height of the river. Measurements of discharge are not made at this point.

111. During 1900 the following measurements were made by E. W. Myers:

February 10: Gage height, 9.70 feet; discharge, 9,361 second-feet.
April 10: Gage height, 7.10 feet; discharge 6,266 second-feet.
April 11: Gage height, 6.90 feet; discharge, 6,002 second-feet.
April 24: Gage height, 25.60 feet: discharge, 49,896 second-feet.
May 11: Gage height, 4.69 feet; discharge, 5,503 second-feet.
June 30: Gage height, 10.12 feet; discharge, 9,530 second-feet.
August 10: Gage height, 1.40 feet; discharge, 2,342 second-feet.
November 2: Gage height, 3.18 feet; discharge 3,734 second-feet.

Daily gage height, in feet, of Roanoke River at Neal, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	7.80	16.40	12.20	12.90	5.80	9.15	7.40	2.15	1.80	3.70	8.70
2	2.10	6.70	18.50	11.60	11.50	5.40	8.10	4.80	2.50	2.60	3.20	6.50
3	2.00	5.00	21.80	11.10	10.40	5.20	7.20	3.30	1.80	1.90	2.80	5.30
4	2.20	4.30	23.10	10.20	9.60	4.80	6.30	2.70	1.20	1.20	4.00	4.60
5	2.20	4.60	24.65	9.50	8.80	4.50	5.30	2.60	.70	1.25	6.40	4.70
6	3.50	6.80	23.80	9.00	8.10	4.20	4.50	2.25	.40	1.45	7.80	11.75
7	4.30	12.70	21.50	8.50	7.60	4.50	4.00	1.90	.40	1.45	9.00	20.75
8	4.30	12.70	19.00	8.10	7.20	4.50	3.70	1.60	.30	1.50	7.90	18.80
9	4.30	11.10	17.30	7.50	7.00	4.30	3.70	1.30	.30	1.90	6.50	14.60
10	4.50	9.75	17.70	7.20	7.10	4.20	3.40	1.30	.70	2.90	5.10	11.80
11	5.10	9.90	18.10	6.90	7.00	4.10	3.00	1.20	.50	3.50	4.20	9.40
12	7.00	11.10	18.30	6.90	6.60	4.20	2.90	1.00	.20	3.20	3.70	7.70
13	12.00	13.10	17.30	8.50	6.30	4.15	3.10	.90	.10	3.20	3.40	6.60
14	19.60	20.50	15.30	9.80	5.90	4.00	2.60	.80	.30	2.20	3.10	5.80
15	19.90	22.50	13.60	10.20	5.50	4.10	2.50	.60	.40	2.10	2.85	5.10
16	17.60	23.88	12.70	9.70	5.20	7.60	2.30	.40	.40	1.70	2.80	4.70
17	14.30	23.90	12.10	8.50	4.80	9.90	2.80	.40	.10	2.80	2.70	4.30
18	11.70	22.80	13.40	7.50	4.70	11.20	2.50	.60	1.80	3.90	2.50	4.20
19	10.20	19.70	14.40	7.10	4.95	17.40	2.00	.40	12.40	3.70	2.40	3.85
20	9.30	17.00	14.10	21.75	5.10	16.10	1.90	.40	9.20	2.90	2.25	3.70
21	18.05	14.70	13.40	23.40	7.80	12.90	1.60	.40	6.20	2.20	2.25	3.80
22	21.25	13.60	13.90	24.63	7.60	9.80	1.40	.40	3.80	1.70	2.20	4.40
23	23.40	14.60	15.80	25.95	6.70	8.00	1.40	.40	2.50	1.50	2.28	4.90
24	23.50	21.65	15.80	25.55	5.90	6.70	1.50	.70	1.30	1.35	2.35	5.40
25	21.60	22.30	13.50	24.20	6.00	6.30	6.00	.90	1.45	1.20	2.50	6.40
26	18.50	22.10	12.70	23.60	6.60	11.50	9.60	2.00	1.35	5.50	2.60	6.80
27	15.80	20.95	13.00	21.10	14.70	15.20	8.60	2.10	1.80	15.40	2.70	8.20
28	13.10	18.80	14.30	18.40	13.70	13.00	10.45	1.50	2.40	11.80	3.00	7.90
29	11.70	.....	14.20	16.00	10.40	12.00	13.60	1.10	2.50	8.50	11.60	6.95
30	10.40	.....	13.40	14.30	8.00	10.45	13.45	1.10	2.50	6.10	11.40	5.90
31	9.10	.....	13.30	.....	6.70	.....	10.40	1.40	.....	4.60	.....	5.90

DAN RIVER AT SOUTH BOSTON, VIRGINIA.

This station, which was established August 27, 1900, by E. W. Myers, is located in the town of South Boston, Virginia, on the railroad bridge of the Norfolk and Western Railroad which crosses the river at that place. The gage rod is laid off on the downstream guard rail of the bridge, the graduations being indicated by brass nails driven into the rail. The zero of the rod is exactly over the center of the first span from the north end of the bridge. The distance between the zero of the rod and the outer rim of the pulley is 2.39 feet; and the distance between the end of the weight and the pointer on the wire rope is 36.44 feet. When the gage reading is 1 foot the water surface is 31.06 feet below the top of the head of the nut on the pin connecting the two tension rods with the lower chord of the bridge, this pin being on the lower side of the bridge and exactly opposite the zero of the gage. This is a very good station for

the gaging of all except the very highest stages of flow. At extreme heights the river spreads out over a flood plain of considerable width. The trestle connecting the bridge with the embankment on the south side of the river is a curve of rather high degree. The bed of the stream is of coarse sand and probably shifts only slightly. R. M. Taliaferro, South Boston, Virginia, is the observer. During 1900 the following measurements were made by E. W. Myers:

August 27: Gage height, 1.00 foot; discharge, 1,046 second-feet.
October 31: Gage height, 2.20 feet; discharge, 1,576 second-feet.

Daily gage height, in feet, of Dan River at South Boston, Virginia, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	0.62	1.50	2.00	3.00	17	8.55	2.40	1.70	3.00
2	.55	1.50	2.20	3.00	18	3.60	2.40	1.70	3.00
3	.95	1.50	2.00	3.00	19	2.00	2.00	1.70	2.90
4	.95	1.50	2.40	4.00	20	1.65	2.00	1.70	2.90
5	.60	1.40	2.10	14.10	21	1.25	1.90	1.70	3.00
6	.95	1.30	2.50	8.00	22	1.55	2.00	1.70	3.10
7	.77	1.90	2.70	4.80	23	1.30	2.00	1.60	3.10
8	.90	1.90	2.50	3.80	24	1.70	2.30	1.60	3.10
9	.37	2.40	2.50	3.50	25	1.70	7.50	1.60	3.00
10	.40	2.40	2.40	3.20	26	1.50	3.50	2.20	3.00
11	.50	2.40	2.00	3.20	27	1.60	3.50	5.60	3.00
12	.30	2.20	2.00	3.20	28	1.40	2.50	3.80	3.20
13	.40	2.20	2.00	3.20	29	1.30	2.50	3.20	3.00
14	.45	2.30	1.90	3.10	30	1.30	2.00	3.00	2.70
15	.40	2.00	1.90	2.90	31	.....	2.00	.....	2.80
16	4.90	2.00	1.80	2.90					

STAUNTON RIVER AT RANDOLPH, VIRGINIA.

This station, which was established August 27, 1900, by E. W. Myers, is about five-eighths of a mile southwest of Randolph station, on the line of the Southern Railway from Richmond to Danville, on the railroad bridge which crosses the river at that place. The rod is laid off on the guard rail of the bridge on the downstream side, the graduations to feet and tenths being indicated by brass tacks. The zero of the gage rod is over the center of the fifth floor beam of the second span from the north end of the bridge. The distance between the zero of the rod and the outer rim of the pulley is 3.66 feet; the distance between the end of the weight and the pointer on the wire rope is 41.13 feet. When the gage reading is 1 foot the water surface is 34.85 feet below the top surface of the fifth floor beam, directly under the zero of the gage. The river is straight for a long distance above and below the bridge, and the velocity of the current is very well distributed. It is said that the rise at this point is about 25 feet. It is not probable that the channel changes to any degree during high water. The observer at this station is Justin Field, station agent at Randolph. During 1900 the following measurements were made by E. W. Myers:

August 27: Gage height, 1.00 foot; discharge, 1,349 second-feet.
October 31: Gage height, 2.75 feet; discharge, 2,304 second-feet.

Daily gage height, in feet, of Staunton River at Randolph, Virginia, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.30	2.60	3.70	17	6.90	2.05	2.30	3.00
2	1.00	1.35	2.50	3.30	18	3.80	1.70	2.30	3.00
3	.75	1.60	2.80	3.05	19	2.05	1.50	2.25	3.00
4	.70	1.50	4.40	4.75	20	1.60	1.45	2.30	3.05
5	.75	1.55	4.60	15.50	21	1.35	1.40	2.30	3.15
6	2.00	2.00	4.00	10.50	22	1.30	1.35	2.35	3.50
7	1.00	1.80	3.45	6.75	23	1.40	1.50	2.30	3.70
8	.80	1.60	3.10	5.50	24	1.35	6.00	2.25	5.70
9	.70	1.80	2.95	4.80	25	2.50	15.15	2.25	4.80
10	.50	2.00	2.75	4.35	26	2.00	6.10	3.10	4.00
11	.50	1.65	2.60	4.00	27	1.50	4.50	12.40	3.80
12	.40	1.00	2.55	3.75	28	1.40	3.70	6.50	3.50
13	.30	1.50	2.55	3.60	29	1.55	3.30	4.75	3.50
14	.30	1.55	2.50	3.40	30	1.40	3.00	4.00	3.30
15	1.00	2.05	2.45	3.30	31		2.75		3.95
16	9.10	2.50	2.35	3.20					

TAR RIVER AT TARBORO, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 110. Extensive sand bars have formed in the channel during periods of extreme low water, and they modify very materially the relation between the gage height and the discharge at low stages of the river. The highest recorded flood was on February 11, 1899, when the gage height was 25 feet and the discharge was probably 19,850 second-feet. The lowest recorded flow was on November 2, 1900, the discharge being 87 second-feet, the maximum flow thus being about 218 times the minimum flow. The observer is R. H. Williams, who reads the gage once a day during ordinary stages of the river, but oftener during floods. Measurements of discharge are made at the station and occasionally at the highway bridge crossing the stream about 200 yards above, as the lower section is sometimes obstructed by rafts of logs. Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 112. During 1900 the following measurements were made by E. W. Myers:

April 11: Gage height, 4.48 feet; discharge, 1,915 second-feet.
April 23: Gage height, 14.90 feet; discharge, 10,237 second-feet.
May 18: Gage height, 2.18 feet; discharge, 1,003 second-feet.
June 30: Gage height, 2.30 feet, discharge, 1,030 second-feet.
August 9: Gage height, 0.40 foot, discharge, 371 second-feet.
November 2: Gage height, —0.30 foot; discharge, 87 second-feet.
November 21: Gage height, 0.50 foot; discharge, 412 second-feet.

Daily gage height, in feet, of Tar River at Tarboro, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	4.0	10.0	3.6	5.0	2.6	2.0	1.7	0.8	—0.2	—0.3	0.8
2	3.0	3.8	10.5	9.0	4.5	2.1	1.3	1.3	.4	— .2	— .2	.7
3	2.9	3.7	12.3	9.1	4.6	2.0	1.5	1.6	.3	— .2	— .3	.6
4	2.6	3.6	13.5	8.0	4.3	1.9	1.6	1.8	.2	— .2	1.7	1.3
5	2.5	3.5	14.3	7.5	4.0	1.8	1.0	.7	.0	— .2	3.4	1.2
6	2.6	4.8	13.0	7.6	3.7	1.5	1.1	.6	.0	— .1	4.5	1.6
7	3.4	6.0	10.5	7.3	3.4	1.3	.7	.5	.0	— .2	5.1	3.7
8	3.5	5.9	8.3	6.0	3.2	1.2	.6	.2	— .1	— .2	3.8	3.0
9	3.4	5.4	7.8	5.3	3.0	1.3	.7	.1	— .1	1.2	3.4	2.1
10	4.3	5.0	9.0	5.0	3.3	1.5	.6	.0	— .1	.5	2.0	1.6
11	3.4	6.1	11.2	4.7	3.6	2.0	.4	.0	— .1	.4	1.6	1.7
12	3.3	7.8	12.2	4.5	4.0	1.8	.3	.0	— .2	.3	1.4	1.5
13	3.7	10.6	11.4	5.6	3.1	1.3	.4	.0	— .2	.4	1.3	1.2
14	9.4	12.8	9.8	8.7	2.8	1.4	.3	.0	— .2	.2	1.0	.9
15	10.5	14.5	8.0	9.8	2.5	1.0	.2	.1	— .2	.1	.6	.8
16	9.5	15.8	7.3	9.3	2.4	1.4	1.6	.3	— .2	.0	.4	.7
17	7.3	17.0	8.3	8.3	2.2	2.5	1.4	1.3	— .2	.0	.6	.6
18	6.2	18.0	9.1	7.2	2.0	3.5	.7	.5	.5	.0	.4	1.1
19	5.9	16.5	9.5	6.0	4.0	6.0	.3	1.0	1.0	.0	.2	.7
20	6.7	13.7	8.5	9.4	5.0	7.3	.2	.7	.4	.0	.7	.6
21	8.9	9.8	7.3	10.8	4.8	5.5	.1	.6	.2	— .1	.4	1.2
22	9.5	8.0	7.1	13.2	4.2	4.3	.0	.4	.0	— .1	.2	2.1
23	10.3	10.0	6.5	14.5	3.4	3.5	.0	.2	.0	— .1	.1	3.7
24	9.0	11.5	6.0	15.3	3.0	3.5	.0	.1	.0	— .2	.3	4.6
25	7.3	13.9	6.1	13.8	4.5	4.3	.0	.0	— .1	— .2	.4	4.0
26	6.4	13.7	6.3	11.0	5.9	6.5	.5	.1	— .1	— .1	.5	2.8
27	5.5	12.6	8.3	8.6	5.6	5.0	1.0	.2	— .1	— .1	.4	2.6
28	5.0	11.9	9.5	7.2	4.5	4.5	1.2	.0	— .1	— .1	.3	2.2
29	4.6	.....	10.0	6.0	3.6	3.4	4.5	.0	— .1	— .2	1.3	2.0
30	4.5	.....	9.1	5.4	3.0	2.6	3.0	.4	— .1	— .3	1.2	2.5
31	4.4	.....	7.8	.....	2.8	.....	2.3	.6	.....	— .3	.....	3.2

NEUSE RIVER AT SELMA, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 111. The maximum flood of which there is any record was on February 9, 1899, when the water reached a height of 21 feet on the gage, with a probable discharge of 12,000 second-feet. The minimum flow occurred during the very severe drought of 1897, the lowest gage height being —0.4 foot, on October 17 and 18, and the discharge 75 second-feet, making the maximum flow about 160 times the minimum flow. The drainage area above the station is 1,175 square miles. Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 114. During 1900 the following measurements were made by E. W. Myers:

February 8: Gage height, 3.40 feet; discharge, 1,117 second-feet.
April 12: Gage height, 3.80 feet; discharge, 1,076 second-feet.
April 24: Gage height, 17.05 feet; discharge, 9,027 second-feet.
May 17: Gage height, 1.70 feet; discharge, 461 second-feet.
June 27: Gage height, 3.00 feet; discharge, 590 second-feet.
August 10: Gage height, 0.61 foot; discharge, 189 second-feet.
November 6: Gage height, 4.60 feet; discharge, 1,278 second-feet.
November 22: Gage height, 0.90 foot; discharge, 248 second-feet.

Daily gage height, in feet, of Neuse River at Selma, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.4	1.8	8.7	3.8	6.3	1.5	4.7	2.0	1.8	0.7	0.1	1.0
2	1.9	1.7	12.5	3.6	5.8	1.5	3.2	1.8	1.5	.7	.2	.9
3	2.1	1.5	12.8	3.5	4.6	1.4	2.0	1.6	1.0	.7	1.4	1.0
4	1.5	2.0	13.1	3.5	3.8	1.3	1.8	1.3	0.8	.6	2.4	1.4
5	1.4	2.5	8.4	3.4	3.2	1.2	1.5	1.2	.7	.5	4.2	4.3
6	1.2	3.1	7.0	3.4	3.1	1.2	1.4	1.0	.6	.4	6.0	7.1
7	1.0	3.0	6.4	3.3	2.8	1.3	1.3	.9	.6	.3	3.1	5.2
8	1.1	3.0	7.2	3.3	2.5	1.4	1.3	.9	.5	.3	2.3	3.1
9	2.1	3.3	8.4	3.2	3.4	1.6	1.2	.8	.5	.3	1.7	2.6
10	3.0	3.3	9.6	3.0	4.0	1.7	1.1	.7	.4	.4	1.5	2.0
11	5.9	7.6	9.0	5.3	3.0	1.6	1.0	.6	.4	.5	1.4	1.8
12	9.7	9.8	8.4	7.8	2.2	1.5	.8	.6	.4	.6	1.4	1.7
13	10.5	14.6	7.0	11.2	2.1	1.4	1.0	.5	.4	.7	1.3	1.6
14	11.2	17.0	5.6	8.1	2.0	1.4	1.4	.5	.4	.7	1.2	1.2
15	9.6	17.8	4.0	4.5	1.8	1.3	1.2	.4	1.5	.7	1.2	2.0
16	7.7	17.0	7.8	5.9	1.7	1.7	1.1	.8	5.5	.8	1.1	1.6
17	3.5	16.0	10.0	8.2	1.8	1.8	1.0	2.0	3.8	.8	1.0	1.5
18	3.2	12.4	8.7	10.4	3.0	1.8	.9	2.4	2.1	.7	.9	1.3
19	2.8	8.6	6.9	11.0	8.0	2.0	.8	1.0	1.0	.6	.9	1.2
20	4.2	4.0	5.1	12.3	7.2	2.1	.7	.8	.9	.5	.9	1.0
21	6.5	5.0	4.8	14.5	5.6	1.7	.6	.6	.8	.4	.8	2.2
22	5.5	6.4	4.3	17.2	3.4	2.3	.8	.6	.7	.4	.8	3.4
23	4.2	8.5	3.0	18.2	2.0	4.6	1.8	.6	.7	.4	.8	5.2
24	3.5	12.1	3.7	17.0	2.5	5.1	3.6	.7	.7	.5	.8	3.8
25	3.3	10.2	3.7	13.8	3.3	6.1	5.3	.6	.7	.5	1.0	2.7
26	3.1	8.6	4.7	8.5	2.8	5.7	3.4	.7	.7	.3	2.0	2.2
27	2.8	6.8	4.9	4.7	2.5	4.3	12.0	.7	.7	.2	4.5	1.8
28	2.8	5.1	4.7	3.8	2.2	3.2	7.8	.6	.7	.1	3.2	1.6
29	2.2	.....	4.5	3.4	2.0	2.7	4.2	1.1	.7	.1	2.1	1.0
30	2.0	.....	4.3	3.3	1.9	3.7	2.9	4.0	.7	.1	1.6	2.0
31	1.9	.....	4.0	.....	1.7	.....	2.6	2.3	.....	.1	.....	4.3

DEEP RIVER AT CUMNOCK, NORTH CAROLINA.

This station was established June 29, 1900, by E. W. Myers. It is 300 yards northwest of the railroad station at Cumnock. The wire gage, which is graduated to feet and tenths, is nailed to the guard rail of the bridge. The water surface is 37.41 feet below the top of the lower chord at the side of the tension rod supporting the floor beam opposite the gage. The initial point of sounding is at the northwest end of the bridge. The channel is straight for several hundred feet above and below the bridge, but the current is rather sluggish during low water. The bed of the stream is muddy, with some bowlders. The observer is J. A. Rollins, a watchman at Cumnock. During 1900 the following measurements were made by E. W. Myers:

June 29: Gage height, 3.00 feet; discharge, 540 second-feet.
August 11: Gage height, 1.30 feet; discharge, 112 second-feet.
November 5: Gage height, 4.55 feet; discharge, 1,118 second-feet.
December 19: Gage height, 1.70 feet; discharge, 199 second-feet.

Daily gage height, in feet, of Deep River at Cumnock, North Carolina, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.24	1.54	2.02	1.31	1.32	1.58	17	(a)	1.75	4.40	1.95	1.69	1.58
2	2.04	1.54	1.79	1.35	1.24	1.70	18	(a)	1.20	2.04	1.66	1.39	1.38
3	1.85	1.65	1.69	1.14	1.39	2.94	19	(a)	.85	1.92	1.57	1.80	1.75
4	2.95	1.37	1.47	1.21	9.19	6.96	20	1.24	1.14	1.78	1.39	1.72	1.70
5	2.14	1.35	1.34	1.10	5.43	9.99	21	.72	1.10	1.67	1.34	1.71	5.77
6	1.87	1.53	1.35	1.16	2.89	4.66	22	.96	1.12	1.45	1.38	1.80	8.23
7	(a)	1.34	1.44	1.00	2.26	3.17	23	1.25	1.45	1.43	1.43	1.39	4.63
8	(a)	1.13	1.36	1.28	1.88	2.26	24	1.88	2.34	1.53	1.50	1.44	3.31
9	(a)	1.18	1.27	1.50	1.83	2.13	25	1.54	1.76	1.55	1.36	1.28	3.10
10	(a)	1.29	1.37	1.77	1.68	1.90	26	1.50	1.46	1.56	1.28	1.82	2.95
11	(a)	1.30	1.37	1.82	1.60	1.72	27	4.27	1.41	1.51	1.34	1.86	2.88
12	(a)	1.20	1.32	1.60	1.50	1.74	28	3.39	1.34	1.55	1.14	1.55	2.24
13	(a)	1.27	1.37	1.46	1.40	1.85	29	2.35	1.25	1.50	1.30	1.45	2.23
14	(a)	1.30	1.45	1.32	1.34	1.70	30	1.90	2.35	1.21	1.33	1.80	2.35
15	(a)	1.43	1.50	2.11	1.33	1.50	31	1.54	2.59	.....	1.40	.....	9.22
16	(a)	1.37	8.52	2.11	1.62	1.66							

a No record.

CAPE FEAR RIVER AT FAYETTEVILLE, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 115. The maximum flood of which there is any record occurred on January 12, 1895, when the river reached a height of 58 feet on the gage, and the discharge was at the rate of about 91,000 cubic feet per second. The lowest stage of flow was on October 8 and 9, 1897, when the gage height was 0.2 foot and the discharge 340 second-feet. The maximum discharge is therefore about 270 times the minimum flow. The drainage area above the station is 44.93 square miles.

Moncure station on Haw River was abandoned January 1, 1900. A measurement was made on June 28, however, when the gage read 2.68 feet; the area of the section was 611 square feet, the mean velocity 1.25 feet per second, and the discharge 769 second-feet. Discharge measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 115.

Moncure station on Deep River was also abandoned January 1, 1900. Measurement was made on June 27, when the gage read 3.67 feet; the area of section was 600 square feet, the mean velocity 1.14 feet per second, and the discharge 687 second-feet. Measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 117.

Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 119. During 1900 the following measurements were made by E. W. Myers:

February 9: Gage height, 6.90 feet; discharge, 3,748 second-feet.
April 12: Gage height, 6.10 feet; discharge, 2,686 second-feet.
April 25: Gage height, 25.30 feet; discharge, 13,479 second-feet.
May 17: Gage height, 3.80 feet; discharge, 1,596 second-feet.
June 29: Gage height, 5.80 feet; discharge, 2,331 second-feet.
August 11: Gage height, 0.70 foot; discharge, 415 second-feet.
November 3: Gage height, 0.75 foot; discharge, 416 second-feet.

Daily gage height, in feet, of Cape Fear River at Fayetteville, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	5.2	12.0	9.0	8.3	3.2	5.0	2.6	5.0	0.9	0.6	2.8
2	4.9	5.0	27.0	7.7	9.7	3.2	4.3	2.8	4.5	.8	.5	2.2
3	4.8	4.6	38.7	6.9	7.3	3.0	4.0	2.2	3.8	.7	.7	2.1
4	4.4	4.4	29.0	6.7	6.9	2.8	3.5	1.8	2.5	.6	2.5	2.3
5	4.2	5.3	22.3	9.1	6.4	2.8	3.1	1.8	1.8	.9	12.5	14.0
6	4.4	7.5	15.0	10.0	5.6	2.7	3.6	1.4	1.2	1.2	10.5	15.0
7	4.2	10.0	11.7	9.2	5.3	2.7	3.1	1.4	.8	1.0	7.0	9.2
8	4.1	8.0	9.7	6.7	5.0	2.6	3.1	1.2	.7	.8	5.2	8.4
9	3.9	6.4	10.0	6.0	5.0	3.5	2.6	.9	.6	.7	4.0	6.5
10	3.9	7.0	23.0	5.8	4.9	3.9	2.2	.8	.4	.7	3.4	4.8
11	4.8	10.0	19.0	5.8	5.5	4.2	1.8	.7	.6	.9	2.9	4.0
12	9.0	20.8	17.2	5.6	5.5	4.2	1.6	.7	.5	.8	2.5	3.5
13	21.3	25.7	14.3	18.0	5.0	3.0	1.4	.7	.3	1.8	2.4	3.4
14	21.0	36.0	10.4	18.0	4.7	2.6	1.8	.7	.4	1.6	2.0	3.3
15	17.3	35.8	8.7	14.4	4.0	2.5	5.0	.8	.5	1.3	1.9	3.3
16	12.0	30.0	9.8	10.2	3.8	3.0	3.0	.6	2.1	1.4	2.0	3.4
17	9.1	24.7	19.0	7.0	3.8	2.7	2.5	.5	10.4	2.9	1.8	3.1
18	7.5	18.4	19.0	6.0	3.6	5.5	2.0	4.5	8.4	2.7	1.5	3.0
19	6.5	13.7	15.0	6.0	8.0	14.0	1.7	3.9	4.6	1.9	1.3	3.0
20	7.7	9.0	12.4	38.0	18.0	8.0	1.5	2.8	3.2	1.6	1.1	2.6
21	12.5	8.2	10.0	44.0	14.0	5.7	1.3	2.4	2.1	1.2	1.0	4.0
22	14.0	9.1	9.4	44.0	10.4	4.4	1.1	1.7	1.7	1.0	1.1	12.8
23	11.7	23.0	8.5	38.0	7.0	4.0	1.0	1.6	1.4	.9	1.1	16.0
24	8.0	23.0	7.6	33.0	5.4	12.0	.9	3.5	1.3	.8	1.1	11.4
25	7.1	17.5	7.0	26.0	5.7	17.4	3.5	2.2	1.0	.8	1.1	9.8
26	6.5	21.0	9.8	22.0	5.5	16.0	3.8	2.3	.9	.7	1.5	7.0
27	6.1	19.0	14.0	17.0	5.5	13.7	4.5	1.7	.8	.7	1.5	5.6
28	5.6	14.1	14.0	12.2	5.0	8.0	12.0	1.2	1.3	.8	2.5	4.4
29	5.7	.....	11.6	10.0	4.5	5.5	9.0	.9	1.0	.6	3.2	4.0
30	5.5	.....	9.8	8.3	4.0	5.0	5.8	.9	1.1	.7	3.1	4.4
31	5.3	.....	9.6	.....	3.7	.....	4.6	1.1	.....	.7	.....	6.2

YADKIN RIVER AT SILOAM, NORTH CAROLINA.

On August 2, 1900, a temporary station was established on Yadkin River at Siloam, North Carolina, by Cleveland Abbe, jr., and N. C. Curtis. Many miscellaneous measurements were also made on the upper tributaries of the Yadkin in connection with the general hydrographic study of the southern Appalachian region, records of which will be found in Water-Supply Paper No. 49.

The gaging station at Siloam is located on the north bank of the river, in a clump of overhanging trees, 50 yards above Hall's ferry and one-third of a mile south of the Siloam station, on the Wilkesboro division of the Southern Railroad. The gage rod, which is graduated to feet and tenths, is securely braced in a clump of trees. The gage is referred to a bench mark on the south bank in a clump of three sycamores at the water's edge, 25 feet above the ferry landing. A notch cut on the outermost tree is 8 feet from the root, and the bench mark is the top of the knot opposite this notch. The reading of the gage on August 2, 1900, was 2.7 feet, equal to 9.6 feet on the old gage, referred to the bench mark across the river, measuring to the surface of the water. The river is said to rise not more than 9 feet in ordinary freshets, but in 1898, as shown by flood marks and according to verbal accounts, it must have risen to about 16 feet on the present gage. The initial point of sounding is on the right bank, at the outer edge of the first stake on the upstream side of the rod. The banks are high and rarely are submerged. The bed of the stream is

gravel and sand, slightly shifting. The drainage area of the river at this station is 1,219 square miles. The observer is C. E. Scott, of Siloam. During 1900 the following measurements were made by N. C. Curtis:

July 11: Gage height, 2.9 feet; discharge, 1,367 second-feet.
August 3: Gage height, 2.6 feet; discharge, 1,218 second-feet.
October 31: Gage height, 3.1 feet; discharge, 1,469 second-feet.

Daily gage height, in feet, of Yadkin River at Siloam, North Carolina, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.00	2.10	2.50	2.60	17	2.10	(a)	2.30	2.50	2.60
2	.....	2.00	2.10	2.50	2.60	18	2.10	(a)	2.30	2.50	2.60
3	2.10	2.00	2.20	2.80	2.70	19	2.10	(a)	2.30	2.50	2.60
4	2.05	2.00	2.20	2.60	2.70	20	2.10	(a)	2.30	2.50	2.60
5	2.00	2.00	2.30	2.40	2.60	21	2.60	(a)	2.30	2.60	2.70
6	1.95	2.00	2.30	2.40	2.60	22	3.05	(a)	2.60	2.60	2.70
7	1.90	2.00	2.30	2.40	2.60	23	2.95	(a)	3.10	2.50	2.70
8	1.90	2.00	2.40	2.50	2.60	24	3.00	(a)	11.20	2.50	2.70
9	1.90	2.00	2.30	2.50	2.60	25	2.90	(a)	4.50	2.80	2.60
10	1.80	2.00	2.30	2.40	2.70	26	2.75	(a)	3.60	11.30	2.60
11	1.80	2.00	2.30	2.40	2.70	27	2.70	(a)	3.40	10.80	2.70
12	1.80	2.00	2.30	2.40	2.70	28	2.00	(a)	3.20	10.60	2.70
13	1.85	2.00	2.60	2.40	2.60	29	2.00	(a)	2.60	9.00	2.70
14	2.05	2.05	2.40	2.40	2.60	30	2.00	(a)	2.60	2.80	3.10
15	2.10	2.20	2.30	2.40	2.60	31	2.00	.....	2.60	.....	3.20
16	2.10	(a)	2.30	2.50	2.60						

a No record.

YADKIN RIVER AT SALISBURY, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 116. Owing to the inconvenient location of the railroad bridge from which the measurements were made and its height above the water, the gaging station was moved June 1, 1899, to the new iron highway bridge about 300 yards above the railroad bridge, the new gage reading the same as the old. In its new position the 10-foot mark on the rod is opposite the center of the first strut from the west end of the second span from the west end of the bridge, on the downstream side. The rod is of pine, 3 inches wide, well painted, graduated to feet and tenths, and securely nailed to the inner surface of the guard rail, the top of the rod being flush with the top of the rail. The distance between the zero of the rod and the outer rim of the pulley is 2.13 feet, and between the end of the weight and the pointer on the wire 26.75 feet. The observer is J. T. Yarbrough, keeper of the bridge. The stream here is about the same width as at the railroad bridge, and the section is a fairly good one for gaging purposes, the bottom for the greater part of the width of the stream being hard and rocky. At times the current is very materially modified by large quantities of driftwood lodging against the piers, but it is thought better results can be obtained than at the old station. Although this stream is subject to periods of comparatively low flow, the minimum run-off is large. The lowest recorded flow was 900 second-feet, occurring in September and October, 1897. The highest flood of which there is any record occurred on March 20,

1899, the gage height being 18.80 feet and the measured discharge 115,000 cubic feet per second, showing the maximum discharge to be nearly 128 times the minimum discharge.

Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 120. During 1900 the following measurements were made by E. W. Myers:

February 13: Gage height, 7.43 feet; discharge, 26,682 second-feet.
April 14: Gage height, 2.50 feet; discharge, 3,962 second-feet.
May 19: Gage height, 2.45 feet; discharge, 4,042 second-feet.
May 25: Gage height, 3.82 feet; discharge, 7,930 second-feet.
August 18: Gage height, 1.95 feet; discharge, 1,447 second feet.
November 9: Gage height, 2.30 feet; discharge, 2,095 second-feet.
December 17: Gage height, 2.45 feet; discharge, 3,025 second-feet.

Daily gage height, in feet, of Yadkin River at Salisbury, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.50	4.60	2.60	2.70	2.37	2.90	2.35	2.10	2.60	2.30	2.70
2	1.50	1.50	9.50	2.60	2.60	2.40	2.73	2.20	1.90	2.10	2.30	2.60
3	1.60	1.50	6.90	2.50	2.50	2.30	2.55	2.10	1.90	1.90	2.30	2.50
4	1.60	1.70	4.40	2.60	2.50	2.50	2.50	2.10	1.90	1.90	2.70	3.60
5	1.60	2.80	3.50	2.50	2.40	2.50	2.45	2.20	1.90	2.00	3.05	6.63
6	1.60	2.70	3.00	2.40	2.40	2.41	2.50	1.95	1.85	2.20	2.75	4.80
7	2.00	2.50	2.90	2.30	2.40	2.44	2.30	1.95	1.80	2.10	2.40	3.55
8	2.10	2.30	2.90	2.30	2.30	2.37	2.40	1.95	1.75	2.10	2.30	3.10
9	2.20	2.30	4.30	2.30	2.40	2.55	2.35	1.95	1.75	2.30	2.30	2.80
10	2.30	2.90	4.40	2.20	2.40	2.55	2.35	1.95	1.70	2.60	2.20	2.65
11	2.50	3.90	4.20	2.20	2.30	2.40	2.25	1.90	1.85	2.20	2.25	2.50
12	4.30	4.10	3.50	2.50	2.30	2.30	2.25	1.85	1.70	2.05	2.30	2.50
13	.....	6.00	3.30	2.70	2.30	2.30	2.25	1.85	1.65	2.05	2.20	2.50
14	3.90	9.10	3.00	2.60	2.30	2.70	2.50	1.80	1.65	2.10	2.20	2.50
15	3.00	6.00	2.70	2.00	2.10	2.85	2.40	2.00	1.65	2.05	2.15	2.45
16	2.50	4.10	4.50	2.40	2.10	2.65	2.22	1.85	4.10	2.20	2.15	2.47
17	2.30	3.20	6.10	2.30	2.10	4.78	2.15	1.90	4.95	2.10	2.15	2.40
18	2.30	2.80	4.60	2.30	2.40	4.54	2.00	2.00	2.80	2.00	2.15	2.35
19	2.30	2.40	4.60	9.95	2.50	4.52	1.90	1.90	2.20	2.00	2.15	2.40
20	4.90	2.30	3.70	10.60	2.40	3.47	2.00	1.85	2.00	2.00	2.20	2.40
21	5.50	2.40	4.60	6.00	2.30	2.95	2.00	1.85	2.00	1.90	2.35	2.70
22	4.90	5.60	3.80	7.00	2.10	2.65	2.45	1.90	2.00	2.00	2.30	3.30
23	3.60	6.30	3.20	6.70	2.10	3.57	2.30	2.60	2.25	2.00	2.25	3.30
24	2.60	4.30	3.00	4.50	2.10	7.00	2.65	3.05	2.10	4.55	2.20	3.30
25	2.40	3.80	2.80	3.90	4.00	4.68	2.65	2.25	2.00	6.81	2.20	3.20
26	2.90	3.50	3.90	3.50	3.20	4.40	2.55	2.30	1.90	3.45	4.08	2.90
27	2.30	2.90	3.80	3.30	2.70	4.35	3.30	2.10	1.90	2.90	7.85	2.70
28	2.20	2.90	3.40	3.10	2.30	3.45	3.05	2.00	1.90	2.60	3.90	2.60
29	2.20	.....	3.00	2.90	2.30	3.55	2.55	1.90	1.90	2.50	3.20	2.55
30	2.00	.....	2.90	2.70	2.10	3.50	2.30	1.90	1.75	2.30	2.80	2.55
31	1.90	.....	2.80	.....	2.10	.....	2.20	2.05	.....	2.35	.....	3.25

YADKIN RIVER AT NORWOOD, NORTH CAROLINA.

This station was abandoned January 1, 1900, and no measurements have been made since that date. A description of the station and records of discharge measurements will be found in Water-Supply Paper No. 36, page 118; also in the Twenty-first Annual Report, Part IV, page 121.

CATAWBA RIVER NEAR MORGANTON, NORTH CAROLINA.

During the summer of 1900 a hydrographic investigation was made of the southern Appalachian region. For the purpose of the study, temporary stations were established on Catawba River near Morganton,

on John River near Morganton, and on Linville River near Bridgewater. Many miscellaneous measurements were also made on the headwaters of the Catawba and its tributaries, as well as of other streams, records of which will be found in Water-Supply Paper No. 49.

The Morganton station was established June 19, 1900, at the highway bridge near Morganton, on the road from Morganton to Hartland. The wire gage is suspended from the bridge, and is read on a horizontal scale graduated to feet and tenths and nailed on the guard rail. The river is straight for a distance of 200 feet above and below the station. The banks are high and have never overflowed. The highest flood of the Catawba rose to the floor of the bridge at this station, a height of about 28 feet. The bed is silt and mud and shifts slightly during floods. The drainage area is 757.8 square miles. Upper Creek flows into the Catawba about 200 feet above the station. The observer is J. W. Kincaid, a farmer living about 200 yards from the station. During 1900 the following measurements were made:

June 13: Gage height, 1.33 feet; discharge, 1,393 second-feet.
June 18: Gage height, 2.50 feet; discharge, 4,030 second-feet.
July 6: Gage height, 1.30 feet; discharge, 1,164 second-feet.
August 8: Gage height, 0.60 foot; discharge, 558 second-feet.
September 24: Gage height, 0.50 foot; discharge, 525 second-feet.
November 7: Gage height, 1.50 feet; discharge, 1,374 second-feet.

Daily gage height, in feet, of Catawba River near Morganton, North Carolina, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.53	0.97	0.60	0.50	1.25	1.35
2	.....	1.78	.83	.55	.50	1.25	1.25
3	.....	1.60	.78	.60	.58	2.70	1.65
4	.....	1.48	.75	.53	1.00	1.70	2.40
5	.....	1.43	.75	.55	1.20	1.45	2.30
6	.....	1.30	.70	.50	1.10	1.70	1.97
7	.....	1.23	.70	.45	.80	1.55	1.60
8	.....	1.20	.65	.50	.85	1.25	1.45
9	.....	1.10	.63	.45	.80	1.35	1.50
10	.....	1.50	.60	.45	.75	1.20	1.40
11	.....	1.00	.58	.33	.65	1.20	1.25
12	.....	1.00	.57	.35	.60	1.20	1.20
13	.....	1.25	.65	.33	.55	1.10	1.10
14	.....	1.00	.65	1.55	.58	1.25	1.05
15	.....	.95	.63	2.50	.53	1.25	.....
16	.....	.90	.55	2.15	.53	1.25	.....
17	.....	.87	.63	1.25	.53	1.25	.....
18	.....	.87	.63	1.15	.53	1.00	.....
19	2.50	.83	.53	.80	.53	1.50	.....
20	1.60	.85	.45	.68	.53	1.25	.....
21	1.60	.87	.45	.63	.50	1.00	.....
22	3.37	.83	.65	.43	.50	1.50	.....
23	3.05	.80	.73	.55	8.55	.95	.....
24	3.87	.93	.58	.53	6.48	1.50	.....
25	3.60	1.23	.80	.55	4.15	1.90	.....
26	3.00	1.25	.60	.53	2.95	4.30	.....
27	2.30	2.63	.63	.53	1.80	3.20	.....
28	2.28	1.05	.53	.48	1.60	2.30	.....
29	1.95	1.10	.55	.55	1.60	1.60	.....
30	1.70	1.45	.60	.53	1.40	1.52	.....
31	.....	1.43	.55	.....	1.35	.....	.....

LINVILLE RIVER NEAR BRIDGEWATER, NORTH CAROLINA.

This station, one of the temporary stations established in connection with the hydrographic investigations of the southern Appalachian region, was established July 3, 1900. It is located at Poole's mill, just above the ford on the road between Morganton and Marion. The gage is near the tailrace of the mill, and the gagings are made about 200 feet farther down. The bed is extremely rough and rocky, the current being swift during high water. There are no bridges across this stream, and high-water measurements are therefore difficult to obtain. The bench mark is a cross cut on the rocky cliff on the left bank of the stream. The initial point of sounding is at the end of a log sunk in the sandy right bank. The drainage area at this station is 86.2 square miles. The observer is J. A. Cooper, miller. The following measurements were made during 1900:

June 14: Gage height, 9.92 feet; discharge, 104 second-feet.
July 3: Gage height, 9.54 feet; discharge, 216 second-feet.
July 10: Gage height, 9.90 feet; discharge, 116 second-feet.
August 17: Gage height, 10.15 feet; discharge, 78 second-feet.
September 21: Gage height, 9.8 feet; discharge, 55 second-feet.

Daily gage height, in feet, of Linville River near Bridgewater, North Carolina, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	.....	9.83	10.17	9.75	17	9.83	10.13	9.67	.....
2	.....	9.92	10.17	9.67	18	9.83	10.13	9.67	.....
3	9.54	9.88	10.21	9.58	19	10.04	10.08	10.00	.....
4	9.46	9.83	10.21	9.50	20	10.00	10.08	10.00	.....
5	9.58	9.92	10.25	9.58	21	9.75	10.13	9.92	.....
6	9.54	10.08	10.25	9.58	22	9.92	10.17	9.92	.....
7	9.63	10.00	10.25	9.63	23	9.92	10.17	9.92	.....
8	9.58	10.08	10.29	9.63	24	9.92	10.17	9.92	.....
9	9.71	10.08	10.29	9.63	25	9.83	10.21	10.00	.....
10	9.58	10.08	10.29	9.63	26	9.92	10.17	10.08	.....
11	9.63	10.08	10.29	9.58	27	9.75	10.21	10.08	.....
12	9.67	10.08	10.33	9.50	28	9.75	10.21	10.13	.....
13	9.63	10.08	10.33	9.54	29	9.92	10.21	9.75	.....
14	9.67	10.13	10.29	9.54	30	9.83	10.21	9.75	.....
15	9.71	10.08	10.21	.....	31	9.92	10.21	.....	.....
16	9.67	10.08	7.50	.....					

JOHN RIVER NEAR MORGANTON, NORTH CAROLINA.

This station was established June 17, 1900, by H. A. Pressey and E. W. Myers, at the highway bridge on the road from Morganton to Lenoir. A wire gage is suspended from the bridge, and the readings are made on a gage rod nailed to the guard rail on the downstream side of the bridge. The river channel is straight for 200 feet above and 300 feet below the station. The banks are high and the bed is rocky and permanent in section. The drainage area at this station is 212.8 square miles. The observer is W. A. Clontz, a farmer living

about a third of a mile from the bridge. The following measurements were made during 1900:

June 13: Gage height, 2.64 feet; discharge, 465 second-feet.
June 19: Gage height, 3.50 feet; discharge, 1,202 second-feet.
July 6: Gage height, 2.63 feet; discharge, 511 second-feet.
August 8: Gage height, 1.90 feet; discharge, 135 second-feet.
September 24: Gage height, 1.90 feet; discharge, 148 second-feet.
November 7: Gage height, 2.32 feet; discharge, 367 second-feet.

Daily gage height, in feet, of John River near Morganton, North Carolina, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			2.10		1.80	2.30	2.32
2		2.60	2.08		1.83	2.30	
3		2.55	2.00		1.93	2.50	2.32
4		2.58	2.15		2.43		3.38
5		2.70	1.90		2.38	2.60	3.20
6		2.58	1.88		2.28	2.35	2.85
7		2.45	1.98		2.10	2.35	2.67
8			1.90		2.08	2.30	2.62
9		2.38	1.90		1.98	2.25	
10		2.30	1.90	1.70	1.90	2.25	2.50
11		2.25	1.90	1.70	1.90		2.35
12		2.25		1.70	1.95	2.20	2.32
13		2.30	1.98	1.70	1.90	2.20	2.35
14		2.25	1.88	1.80		2.15	2.30
15			1.93	2.90	1.90	2.15	2.28
16		2.15	1.93		1.88	2.10	
17		2.13	1.93	2.20	1.83	2.05	2.25
18		2.10	1.93	2.03	1.78		2.20
19	3.50	2.10	(a)	1.95	1.73	2.12	2.18
20	3.25	2.15		1.90	1.73	2.15	2.22
21	2.80	2.45		1.90		2.12	3.08
22	3.28			1.90	1.88	2.10	2.92
23	3.20	2.10			14.72	2.08	
24		2.28		1.90	5.60	2.08	2.78
25	3.75	2.35		1.85	3.45		2.68
26	3.58	2.30		1.83	2.98	4.55	2.48
27	3.23	2.23		1.83	2.70	3.00	2.38
28	3.20	2.20		1.80		2.65	2.32
29	2.95			1.83	2.45	2.52	2.28
30	2.85	2.20			2.30	2.42	
31		2.13			2.30		2.90

a No record from August 19 to September 9, inclusive.

CATAWBA RIVER AT CATAWBA, NORTH CAROLINA.

This station was originally established in July, 1896, but was abandoned December 31, 1899. On June 13, 1900, it was reestablished as a temporary station to assist in the study of the hydrography of the southern Appalachian region. The measurements are made from the Southern Railway bridge about a fourth of a mile east of the railway station. The wire gage is suspended from the bridge and is referred to the painted gage rod, which is divided into feet and tenths and nailed to the guard rail. The initial point of sounding is on the west end of the bridge. The channel is straight above and below the station, and the current is moderately swift. The banks are high, and the bed is composed of gravel and fine sand. The observer is C. A. Reed, jr., clerk in the post-office at Catawba. During 1900 the following measurements were made by E. W. Myers:

July 3: Gage height, 3.45 feet; discharge, 3,372 second-feet.
August 14: Gage height, 2.10 feet; discharge, 914 second-feet.
November 7: Gage height, 2.95 feet; discharge, 2,088 second-feet.
December 18: Gage height, 2.59 feet; discharge, 2,139 second-feet.

Daily gage height, in feet, of Catawba River at Catawba, North Carolina, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.15	2.80	(a)	3.55	3.70	2.85
2	.....	2.65	2.70	(a)	3.60	3.50	2.85
3	.....	3.35	2.55	1.80	3.65	3.10	3.40
4	.....	3.15	2.40	1.72	3.70	4.10	4.50
5	.....	3.10	2.40	1.75	3.70	3.20	4.10
6	.....	3.00	2.40	1.90	4.20	3.10	3.85
7	.....	2.90	2.40	1.85	3.90	3.10	3.45
8	.....	2.90	2.35	1.80	3.85	2.95	3.15
9	.....	2.80	2.30	1.78	3.80	2.75	3.00
10	.....	2.75	2.30	1.72	3.75	2.75	2.95
11	.....	2.65	2.30	1.70	3.75	2.75	2.95
12	.....	2.60	2.25	1.75	3.75	2.75	2.80
13	2.35	2.60	2.25	1.75	3.70	2.75	2.85
14	2.80	2.55	2.25	1.65	3.60	2.75	2.80
15	3.15	2.50	(a)	1.85	3.60	2.70	2.70
16	4.85	2.50	(a)	5.00	3.60	2.65	2.75
17	8.65	2.50	(a)	5.70	3.60	2.60	2.75
18	7.50	2.50	(a)	4.40	3.65	2.50	2.60
19	5.05	2.50	(a)	3.55	3.70	2.55	2.60
20	4.55	2.50	(a)	3.10	3.65	2.55	3.10
21	3.45	2.50	(a)	3.30	3.60	2.60	4.85
22	4.75	2.50	(a)	3.55	3.75	2.60	5.20
23	6.14	2.30	(a)	3.55	4.10	2.50	4.75
24	5.75	2.70	(a)	3.55	20.20	2.45	4.20
25	5.65	2.70	(a)	3.50	7.40	3.60	3.80
26	5.40	3.25	(a)	3.45	5.70	9.10	3.35
27	4.15	3.20	(a)	3.40	4.90	5.00	3.15
28	3.65	2.90	(a)	3.38	4.70	4.10	3.00
29	3.45	2.70	(a)	3.30	4.45	3.60	3.10
30	3.30	2.70	(a)	3.40	4.35	3.25	3.35
31	.....	3.00	(a)	.....	3.90	.....	4.05

a No record.

CATAWBA RIVER AT ROCKHILL, SOUTH CAROLINA.

This station, which is described in Water-Supply Paper No. 36, page 121, was established September 3, 1895. During the last year a dam has been constructed across the river about 6 miles above the gaging station, and it is probable that this will modify the flow to some extent, particularly at low stages. The maximum flood of which there is any record at this station occurred March 20, 1899, the water reaching a height of 17.25 feet on the gage, with a probable discharge of about 72,000 second-feet. The lowest stage of flow occurred in September of 1895 and 1896, when a gage height of 1.0 foot was reached, the probable discharge being 1,300 second-feet. During 1900 the following measurements were made by E. W. Myers:

February 21: Gage height, 2.63 feet; discharge, 3,803 second-feet.
February 22: Gage height, 5.28 feet; discharge, 16,791 second-feet.
April 13: Gage height, 2.75 feet; discharge, 4,703 second-feet.
April 21: Gage height, 9.07 feet; discharge, 31,610 second-feet.
May 21: Gage height, 2.42 feet; discharge, 3,703 second-feet
July 4: Gage height, 2.86 feet; discharge, 5,623 second-feet.
August 16: Gage height, 1.70 feet; discharge, 1,936 second-feet.
October 26: Gage height, 3.30 feet; discharge, 8,843 second-feet.

Daily gage height, in feet, of Catawba River at Rockhill, South Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	2.10	4.60	2.80	(a)	2.30	3.00	2.20	1.80	1.40	1.90	2.20
2	1.80	2.00	11.90	2.70	(a)	2.30	2.90	2.10	1.80	1.40	1.80	2.00
3	2.70	2.00	7.90	2.60	(a)	2.20	2.80	2.00	1.80	1.40	1.80	2.00
4	2.70	2.10	4.50	2.50	(a)	2.50	2.80	1.90	1.80	1.40	3.40	3.20
5	2.30	2.20	3.70	2.80	(a)	2.50	2.50	1.90	1.70	1.40	3.00	4.20
6	2.20	2.40	3.30	2.80	(a)	2.40	2.40	1.80	1.70	1.40	2.50	4.10
7	2.00	2.40	3.10	2.60	(a)	2.30	2.40	1.80	1.70	1.70	2.10	2.90
8	2.00	2.00	3.00	2.60	(a)	2.30	2.30	1.80	1.70	1.70	2.00	2.40
9	2.00	2.00	3.80	2.60	(a)	2.40	2.20	1.80	1.60	1.80	2.00	2.20
10	2.00	2.60	4.10	2.50	(a)	2.40	2.20	1.80	1.60	1.60	1.90	2.20
11	1.90	3.80	3.70	2.50	(a)	2.40	2.20	1.70	1.50	1.60	1.80	2.20
12	3.20	3.80	3.40	2.20	2.40	2.30	2.10	1.70	1.50	1.60	1.70	2.20
13	4.70	6.30	3.20	2.70	2.30	2.20	2.10	1.70	1.50	1.60	1.70	2.00
14	3.50	12.30	3.10	2.60	2.30	2.20	2.10	1.70	1.50	1.50	1.70	1.90
15	2.80	7.50	2.90	2.50	2.30	2.60	2.10	1.70	1.60	1.50	1.70	1.90
16	2.50	4.30	5.80	2.50	2.30	2.55	2.10	1.70	1.60	1.50	1.70	1.90
17	2.40	3.40	6.70	2.50	2.25	3.90	2.10	2.00	3.20	1.50	1.70	1.90
18	2.20	3.00	4.50	2.40	2.30	6.75	2.10	2.00	2.70	1.50	1.70	1.80
19	2.00	2.90	3.60	10.00	4.60	6.30	2.10	1.90	2.10	1.40	1.70	1.80
20	2.90	2.60	3.80	(a)	2.60	4.40	2.00	1.90	1.80	1.40	1.70	1.80
21	3.30	2.60	3.80	(a)	2.40	3.30	1.90	1.70	1.80	1.40	1.70	4.20
22	3.20	4.90	3.70	(a)	2.20	2.90	1.90	1.60	1.70	1.35	1.70	3.80
23	2.70	5.40	3.30	(a)	2.20	5.80	2.10	2.30	1.70	1.40	1.70	4.20
24	2.50	4.00	2.30	(a)	2.20	6.50	2.60	2.10	1.40	7.75	1.70	2.90
25	2.40	3.40	2.90	(a)	3.40	5.00	2.60	1.80	1.40	11.30	1.70	2.80
26	2.40	3.30	3.10	(a)	3.60	4.90	2.20	2.00	1.30	3.40	1.80	2.70
27	2.30	3.00	3.70	(a)	2.80	4.00	2.30	1.90	1.30	2.50	6.10	2.50
28	2.20	2.80	3.50	(a)	2.60	3.50	2.50	1.80	1.30	2.20	3.90	2.30
29	2.10	.....	3.20	(a)	2.50	3.20	2.30	1.80	1.30	2.10	2.60	2.20
30	2.10	.....	3.10	(a)	2.40	3.10	2.90	2.00	1.30	2.00	2.30	2.20
31	2.10	.....	3.00	.....	2.30	.....	2.20	1.80	.....	2.00	.....	2.60

a Gage broken; no record.

BROAD RIVER (OF THE CAROLINAS) AT DELLINGER, SOUTH CAROLINA.

The station at Gaffney, South Carolina, was abandoned on account of its poor section, and the station at Dellinger was established August 30, 1900, by N. C. Curtis, in connection with the hydrographic investigations of the southern Appalachian region. The gage is a 4-inch by 4-inch timber, 13 feet long, spiked to a tree on the left bank of the river at Ellis's ferry, Dellinger, 1 mile below the North Carolina–South Carolina State line and 10 miles south of Shelby, North Carolina. The gage is graduated to feet and tenths and reads direct. The initial point of sounding is a stake in the center of the roadway, used for securing ferryboats to the bank. The channel is straight, the current rather rapid, and the bed of the stream sandy and slightly shifting. The right bank is about 10 feet high, and is not subject to overflow; the left bank rises to a considerable height. It has been observed that the surface of the water in the river is about 4 inches higher in the evening than in the morning. This may probably be accounted for by the fact that there are two cotton mills on Second Broad River which close their gates at night, in order to allow the ponds to fill, and cut off nearly all of the discharge of Second Broad River during low water. The observer is J. S. Gramling, ferryman. During 1900 N. C. Curtis made one measurement at this station, as follows:

August 30: Gage height, 0.8 foot; discharge, 1,430 second-feet.

Daily gage height, in feet, of Broad River (of the Carolinas) at Dellinger, South Carolina, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	0.55	0.80	1.35	17	1.50	0.30	0.70	1.00
2	0.60	.60	.70	1.20	18	1.00	.30	.50	.90
3	.70	.50	.70	1.30	19	.70	.30	.70	.90
4	.70	.50	.90	2.50	20	.70	.30	.70	.95
5	.60	.50	.90	3.15	21	.60	.20	.70	5.00
6	.60	1.20	.70	2.00	22	.60	.40	.70	3.25
7	.60	.60	.60	1.70	23	.70	1.00	.70	2.30
8	.50	.70	.60	1.55	24	.70	5.50	.70	2.50
9	.30	1.00	.60	1.20	25	.60	2.50	.90	2.00
10	.50	.80	.60	1.30	26	.50	2.25	6.15	1.90
11	.50	.60	.50	1.20	27	.50	1.28	2.80	1.70
12	.50	.60	.70	1.15	28	.50	1.00	1.90	1.60
13	.40	.50	.70	1.15	29	.50	.90	1.60	1.60
14	.40	.30	.70	1.15	30	.....	.90	1.50	1.75
15	1.20	.75	.70	1.15	31	.....	.80	.....	2.50
16	2.90	.30	.70	.80					

BROAD RIVER (OF THE CAROLINAS) NEAR ALSTON, SOUTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 125. The river is straight for a long distance above and below the station, but the current is at an angle with the bridge. The current velocity is ample and is very uniform throughout the section. The observer is G. M. Heron, a farmer living near the station. The maximum flood at this station was on April 22, 1900, when the gage height was 23.80 feet and the probable discharge about 92,000 second-feet. The minimum flow was reached October 3, 1899, the discharge being 1,485 second-feet. The maximum discharge is, therefore, about 62 times the minimum flow. During 1900 the following discharge measurements were made by E. W. Myers:

February 26: Gage height, 5.40 feet; discharge, 8,913 second-feet.
April 18: Gage height, 6.28 feet; discharge not measured.
April 20: Gage height, 13.60 feet; discharge, 44,456 second-feet.
May 22: Gage height, 3.40 feet; discharge, 4,406 second-feet.
July 5: Gage height, 4.25 feet; discharge, 5,962 second-feet.
August 17: Gage height, 2.80 feet; discharge, 2,840 second-feet.

Daily gage height, in feet, of Broad River (of the Carolinas) near Alston, South Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.99	8.20	4.64	5.00	3.45	5.54	4.00	3.15	2.55	2.95	3.60
2	.....	2.80	14.20	4.41	4.80	3.30	4.90	3.85	3.20	2.30	2.88	3.45
3	.....	2.72	12.47	4.17	4.60	3.48	5.45	3.40	2.80	2.60	3.70	3.25
4	.....	2.74	8.20	4.24	4.40	4.05	5.45	3.30	2.50	2.60	7.51	7.83
5	.....	3.38	6.10	4.58	4.25	4.45	4.25	3.20	2.70	3.05	7.20	9.20
6	.....	3.52	5.52	4.54	4.15	3.90	5.90	3.10	2.60	3.35	5.00	6.50
7	.....	3.90	5.04	4.08	4.10	3.70	3.90	2.80	2.50	3.30	3.75	4.95
8	3.30	3.45	5.16	4.05	3.90	5.05	3.65	3.03	2.50	3.10	3.50	4.25
9	3.45	3.50	8.98	4.00	3.90	4.45	4.76	3.05	2.48	2.70	3.15	3.90
10	3.60	3.58	8.30	3.90	3.70	4.45	3.74	2.90	2.30	3.25	3.05	3.60
11	3.80	8.48	6.63	3.88	3.60	4.20	3.40	2.82	2.05	3.15	2.90	3.55
12	6.30	9.84	5.43	4.50	3.60	3.85	3.30	2.80	2.30	2.90	2.80	3.45
13	7.50	14.48	5.07	4.70	3.65	3.60	3.20	2.85	2.35	2.85	2.70	3.35
14	5.00	19.95	4.66	4.41	3.64	4.05	4.80	2.60	2.38	3.10	3.00	3.60
15	3.80	16.90	4.40	4.40	3.64	4.32	4.40	2.95	2.65	3.00	2.90	3.70
16	3.20	11.11	11.68	3.90	3.54	4.20	3.70	2.90	5.30	2.50	2.85	3.30
17	2.78	7.47	12.80	3.70	3.50	10.00	3.50	2.80	6.12	2.85	2.90	3.05
18	2.38	5.57	8.87	6.40	3.40	12.33	3.40	2.95	4.10	2.70	2.95	3.10
19	2.36	4.92	6.10	17.20	4.80	8.60	3.25	2.85	3.20	2.70	2.95	3.20
20	3.09	4.51	5.30	14.60	4.20	6.00	3.10	2.75	3.05	2.60	2.75	3.30
21	3.87	4.20	6.83	15.50	3.60	5.00	3.10	2.35	2.85	2.65	3.55	7.20
22	3.52	9.25	5.84	23.40	3.47	4.50	2.98	2.60	2.65	2.60	3.35	8.55
23	3.38	9.50	5.39	18.10	3.42	10.55	3.40	2.55	2.58	2.35	3.20	7.20
24	3.73	6.64	5.08	11.80	3.25	13.98	3.10	3.50	2.40	6.95	3.15	5.15
25	3.58	7.50	7.20	10.00	6.50	10.00	3.42	3.35	2.50	8.40	3.05	4.80
26	3.38	5.50	10.80	7.40	6.20	8.00	3.25	2.80	2.80	5.85	3.90	4.45
27	3.29	5.00	8.40	7.30	5.55	6.85	4.32	3.10	2.65	3.90	10.13	4.20
28	3.10	4.50	6.54	6.10	4.40	6.35	4.32	2.60	2.50	3.55	6.35	3.80
29	2.90	.....	5.60	5.65	3.85	5.95	4.35	2.75	2.45	3.30	4.65	3.70
30	2.84	.....	5.11	5.50	3.70	6.15	4.45	2.90	2.45	3.00	3.85	3.95
31	3.10	.....	4.78	.....	3.55	.....	4.95	3.10	.....	3.15	.....	6.30

SALUDA RIVER AT WATERLOO, SOUTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 126. Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 129. During 1900 the following measurements were made by E. W. Myers:

February 23: Gage height, 7.33 feet; discharge, 3,347 second-feet.
April 19: Gage height, 9.91 feet; discharge, 5,415 second-feet.
May 22: Gage height, 3.35 feet; discharge, 757 second-feet.
July 5: Gage height, 5.10 feet; discharge, 1,486 second-feet.
August 17: Gage height, 4.10 feet; discharge 917 second-feet.
November 10: Gage height, 4.42 feet; discharge, 854 second-feet.

Daily gage height, in feet, of Saluda River at Waterloo, South Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	4.00	10.20	6.00	6.40	4.50	7.40	4.35	4.70	3.10	4.35	5.45
2	4.00	4.10	11.95	5.55	6.10	4.20	5.85	4.50	4.90	3.90	4.40	4.90
3	4.55	4.80	10.70	5.05	5.70	4.40	6.45	4.95	4.00	4.10	6.60	4.60
4	4.50	3.95	7.20	5.10	5.70	5.45	6.25	4.70	4.00	4.80	7.75	7.85
5	4.30	4.60	6.35	5.35	5.70	4.90	5.90	4.65	4.10	4.40	4.70	7.90
6	4.05	5.25	6.00	5.15	5.95	5.10	5.65	3.65	4.05	4.60	5.60	5.95
7	3.80	5.30	5.65	5.35	5.00	8.10	5.20	4.05	4.00	3.80	5.40	5.80
8	3.40	5.20	8.80	5.45	4.90	10.90	5.20	4.15	4.65	3.10	4.50	5.55
9	4.00	4.25	10.05	4.35	4.85	10.00	5.40	5.15	3.70	4.10	4.55	5.05
10	4.65	6.75	8.30	4.85	4.95	6.90	4.85	3.95	3.00	5.00	5.15	4.30
11	4.85	7.80	7.40	5.50	4.65	6.00	4.70	5.00	4.28	4.25	4.20	5.40
12	9.55	10.30	6.05	5.90	5.40	5.80	4.55	3.80	4.00	4.10	3.45	5.35
13	7.80	16.40	5.85	5.40	5.00	5.25	4.75	3.65	3.95	4.90	5.10	5.45
14	5.65	20.00	5.70	5.70	5.00	6.20	5.80	3.90	4.10	3.95	5.15	4.90
15	5.05	17.00	5.80	5.05	4.65	7.00	6.10	4.00	4.75	3.20	5.05	5.45
16	5.30	8.40	11.05	5.00	4.83	6.55	4.90	4.55	8.75	4.60	4.40	4.20
17	5.05	7.00	10.70	4.90	4.45	10.25	4.60	4.50	6.10	4.40	4.70	4.25
18	4.90	6.45	8.00	8.65	5.10	8.70	4.60	4.10	4.25	4.65	4.10	5.25
19	5.15	5.90	6.90	9.55	5.75	7.00	4.50	4.00	4.20	4.20	3.50	4.50
20	5.20	5.50	8.10	8.80	5.85	6.50	4.45	3.30	5.20	4.55	4.60	5.20
21	5.45	6.10	7.40	13.40	4.55	5.95	5.30	3.85	4.00	5.80	4.45	5.20
22	4.00	8.50	6.65	16.80	5.20	6.10	4.20	4.10	4.95	3.05	4.50	5.65
23	5.20	7.70	6.10	14.40	4.40	8.55	5.05	4.05	4.15	4.20	5.25	5.15
24	4.90	5.55	6.90	12.55	8.50	11.80	5.30	4.15	3.55	8.30	5.10	5.00
25	5.00	6.90	9.15	9.30	7.35	10.70	4.35	5.20	4.10	8.10	4.50	5.45
26	4.95	5.80	8.15	7.70	6.45	10.80	5.30	4.00	4.10	6.70	10.20	4.85
27	5.00	5.70	7.80	7.40	6.10	8.25	4.40	3.75	4.60	5.35	9.90	4.60
28	3.95	5.20	6.85	7.00	4.50	8.25	5.40	4.40	4.05	4.70	8.40	4.45
29	4.15	.....	6.30	6.55	5.30	7.35	4.95	4.00	4.80	3.90	5.20	5.35
30	4.05	.....	6.10	6.30	4.60	8.30	4.70	4.60	3.80	5.20	5.55	5.55
31	4.00	.....	6.05	.....	5.30	.....	5.30	4.95	.....	5.25	.....	5.70

TALLULAH RIVER AT TALLULAH FALLS, GEORGIA.

This station was established August 29, 1900, and records of gage heights were obtained until October 19, 1900, when the observer left Tallulah Falls, and no readings have been made since that time. Measurements are made from the wagon bridge across the river about a half mile above the head of the falls. The bridge is a single iron span about 100 feet long. The gage is a vertical rod 10 feet long, graduated to feet and tenths, nailed to a 2-inch by 4-inch pine timber, and the whole spiked to a tree on the left bank of the river about 50 feet above the bridge. The observer is T. A. Robinson, proprietor of the Robinson Hotel. During 1900 the following measurements were made by Max Hall and J. C. Conn:

August 29: Gage height, 1 foot; discharge, 252 second-feet.
December 21: Gage height, 2 feet; discharge, 963 second-feet.

Daily gage height, in feet, of Tallulah River at Tallulah Falls, Georgia, for 1900.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	.....	1.50	1.03	12	.....	.85	1.01	23	.....	1.25	.....
2	.....	1.40	1.03	13	.....	.80	1.01	24	.....	1.20	.....
3	.....	1.10	1.02	14	.....	1.20	1.00	25	.....	1.20	.....
4	.....	1.00	1.01	15	.....	1.95	1.00	26	.....	1.19	.....
5	.....	1.00	1.01	16	.....	2.90	1.00	27	.....	1.17	.....
6	.....	1.00	1.03	17	.....	1.95	1.00	28	.....	1.10	.....
7	.....	1.00	1.03	18	.....	1.70	1.00	29	1.00	1.09	.....
8	.....	1.00	1.02	19	.....	1.40	1.00	30	.95	1.04	.....
9	.....	.90	1.02	20	.....	1.35	.....	31	1.60	.....	.....
10	.....	.90	1.01	21	.....	1.30	.....				
11	.....	.90	1.01	22	.....	5.40	.....				

TUGALOO RIVER NEAR MADISON, SOUTH CAROLINA.

This station, established July 19, 1898, at Cook's ferry, about a half mile from Madison, South Carolina, 1 mile below the Southern Railway bridge over Tugaloo River and 2 miles above the mouth of Chauga Creek, is described in Water-Supply Paper No. 36, page 127. Results of measurements are given in the Twentieth Annual Report, Part IV, page 162, and in the Twenty-first Annual Report, Part IV, page 131. During 1900 the following measurements were made by Max Hall and others:

February 21: Gage height, 4.25 feet; discharge, 2,243 second-feet.
August 30: Gage height, 1.71 feet; discharge, 872 second-feet.
December 25: Gage height, 3.60 feet; discharge, 1,717 second-feet.
December 27: Gage height, 2.80 feet; discharge, 1,414 second-feet.

Daily gage height, in feet, of Tugaloo River near Madison, South Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.4	1.6	9.4	3.5	4.2	2.3	5.1	3.1	2.5	1.7	2.1	2.5
2	1.3	1.6	5.5	3.4	4.1	2.6	5.6	2.8	2.8	1.6	2.1	2.4
3	1.3	1.8	3.9	3.4	4.3	2.8	5.1	2.7	2.1	1.7	2.2	2.3
4	1.3	1.7	3.9	3.6	4.0	2.7	4.6	2.5	1.9	1.7	2.9	5.6
5	1.2	3.5	3.7	3.7	3.8	2.9	4.2	2.5	1.8	1.9	2.3	4.8
6	1.2	2.3	3.5	3.4	3.7	2.9	3.9	2.4	1.7	3.2	2.1	3.4
7	1.2	2.1	3.8	3.3	3.6	5.5	3.8	2.3	1.6	1.8	2.0	3.1
8	1.2	2.2	4.3	3.2	3.4	6.7	3.6	2.3	1.6	1.8	2.0	3.0
9	1.2	3.0	6.6	3.1	3.4	4.5	3.8	2.2	1.5	1.5	1.9	2.9
10	1.4	3.5	5.1	3.1	3.3	3.6	3.6	2.1	1.5	1.8	1.9	2.6
11	1.6	4.6	4.5	3.3	3.2	3.3	3.7	2.1	1.5	1.7	1.8	2.5
12	5.5	7.0	4.2	4.1	3.1	3.0	3.6	2.1	1.4	1.6	1.8	2.4
13	3.3	19.9	3.9	3.8	3.1	3.3	3.9	2.2	1.4	2.6	1.8	2.3
14	2.5	9.0	3.7	3.4	3.0	3.3	3.9	2.0	1.6	1.8	1.7	2.3
15	2.1	6.2	3.6	3.2	2.9	3.1	3.7	2.3	8.1	1.6	1.7	2.2
16	2.0	5.2	5.1	3.0	2.9	3.0	3.6	2.1	7.3	1.6	1.7	2.2
17	1.9	4.5	4.0	5.9	2.8	6.9	3.2	2.3	4.0	1.5	1.7	2.1
18	1.8	4.0	3.6	5.1	2.8	5.3	3.1	2.1	2.9	1.5	1.8	2.1
19	4.5	3.8	3.7	7.6	3.3	4.5	3.0	2.0	2.6	1.4	1.9	2.0
20	6.9	3.5	6.2	7.5	2.8	3.9	2.9	1.9	2.3	1.4	2.0	2.3
21	3.4	3.5	5.0	13.4	2.7	3.5	2.8	1.8	2.2	1.4	2.0	4.2
22	3.1	5.0	4.4	8.3	2.6	4.2	2.8	1.8	2.1	1.6	2.0	3.3
23	2.9	4.0	4.2	6.3	2.5	5.8	3.1	2.1	2.0	7.4	1.9	3.0
24	2.4	3.8	4.1	6.2	3.3	13.0	2.9	2.3	2.0	6.8	1.9	4.2
25	2.4	4.0	4.2	5.3	2.9	9.4	2.7	2.1	2.9	4.9	2.2	3.6
26	2.2	3.5	5.8	4.9	2.9	11.4	3.6	2.2	1.8	3.9	9.4	3.1
27	2.1	3.3	4.8	4.6	2.7	6.5	3.2	1.9	2.1	2.9	5.3	2.8
28	1.9	3.1	4.3	4.9	2.5	6.9	3.8	1.8	1.9	2.6	4.1	2.7
29	1.9	.....	4.1	4.7	2.5	6.4	3.1	1.7	1.8	2.5	3.0	2.6
30	1.8	.....	3.9	4.4	2.4	5.7	4.2	1.7	1.7	2.3	3.4	2.6
31	1.8	.....	3.7	.....	2.3	.....	3.3	2.8	.....	2.2	.....	4.0

SAVANNAH RIVER NEAR CALHOUN FALLS, SOUTH CAROLINA.

This station was established August 4, 1896, on the Seaboard Air Line bridge across Savannah River, above the mouth of Beaverdam Creek, below Rocky River, and about 3 miles west of the town of Calhoun Falls, South Carolina. It is described in Water-Supply Paper No. 36, page 129. More than four-fifths of the drainage area of this river in the Blue Ridge Mountains in North Carolina, South Carolina, and Georgia is covered with the original oak forest. Records of flow during 1899 will be found in the Twenty-first Annual Report,

Part IV, page 134. During 1900 the following measurement was made by Max Hall:

March 1: Gage height, 5.47 feet; discharge, 13,808 second-feet.

Daily gage height, in feet, of Savannah River near Calhoun Falls, South Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	2.9	5.3	3.6	4.0	2.8	3.6	3.2	3.2	2.1	2.9	3.0
2	3.2	2.8	6.5	3.5	3.9	2.7	3.2	3.0	3.7	2.0	3.0	2.9
3	3.2	2.8	4.6	3.5	4.2	3.1	3.0	3.0	3.3	2.0	3.9	2.8
4	3.1	2.7	4.2	3.7	4.0	2.9	3.0	2.9	3.0	2.1	4.3	3.9
5	3.0	2.8	3.9	3.6	3.9	3.5	2.9	2.9	3.0	2.1	4.0	3.8
6	3.0	2.8	3.8	3.4	3.7	3.4	2.9	2.8	2.9	3.0	3.8	3.8
7	2.9	2.9	3.6	3.3	3.6	3.9	2.8	2.8	2.8	2.7	3.7	3.7
8	2.9	2.9	4.0	3.4	3.4	11.0	2.7	2.7	2.6	2.6	3.4	3.6
9	2.9	3.0	4.9	3.4	3.3	5.0	2.7	2.6	2.5	2.5	3.3	3.4
10	3.0	3.2	4.3	3.3	3.1	3.5	2.6	2.4	2.3	2.4	3.2	3.4
11	3.2	5.2	3.9	3.6	3.1	3.0	2.5	2.3	2.2	2.4	3.2	3.3
12	4.0	9.3	3.8	4.0	3.0	3.0	2.4	2.2	2.1	2.6	3.0	3.3
13	3.9	15.5	3.6	3.8	3.0	3.1	2.4	2.7	2.0	3.9	2.9	3.4
14	3.7	19.4	3.4	3.6	3.0	3.0	2.5	2.6	2.0	3.0	2.7	3.7
15	3.6	8.0	3.3	3.6	2.9	3.0	2.4	2.5	4.7	2.9	2.7	3.6
16	3.5	5.5	4.6	3.5	2.9	3.3	2.3	2.5	6.9	2.8	2.6	3.4
17	3.3	4.9	4.5	3.5	2.9	5.6	2.2	2.6	5.0	2.6	2.6	3.4
18	3.3	4.7	4.0	3.9	2.8	6.1	2.2	2.6	3.2	2.5	2.6	3.3
19	3.4	4.4	3.8	5.0	3.0	4.9	2.1	2.4	3.0	2.5	2.6	3.3
20	3.9	4.3	4.2	5.1	3.0	4.0	2.1	2.3	2.9	2.4	3.0	3.6
21	3.8	4.2	4.0	8.0	2.9	3.7	2.1	2.2	2.9	2.4	2.9	3.7
22	3.6	5.4	3.9	10.4	2.9	3.6	2.0	2.0	2.7	2.4	2.8	3.5
23	3.5	4.7	3.8	5.5	3.0	4.0	2.2	2.0	2.7	2.5	2.8	3.4
24	3.4	4.4	4.0	6.9	4.9	12.7	2.3	1.9	2.6	5.0	2.6	3.4
25	3.2	4.2	5.6	6.0	4.2	12.0	2.2	2.5	2.4	4.0	2.6	3.3
26	3.2	4.0	5.7	4.9	3.2	7.8	2.2	2.9	2.4	3.9	3.6	3.3
27	3.1	3.9	5.0	4.2	3.0	5.0	2.3	2.7	2.2	3.7	3.4	3.3
28	3.0	3.9	4.8	4.0	3.0	4.5	3.4	2.9	2.0	3.5	3.2	3.2
29	3.0	.....	4.2	4.2	2.9	3.9	3.2	2.3	2.0	3.3	3.1	3.2
30	3.0	.....	3.9	4.0	2.9	3.8	3.4	2.2	2.1	3.1	3.0	3.3
31	2.9	.....	3.7	.....	2.8	.....	3.1	2.1	.....	2.9	.....	3.3

SAVANNAH RIVER AT AUGUSTA, GEORGIA.

Observations of river heights have been maintained at the highway bridge in the city of Augusta since 1875. The station is described in Water-Supply Paper No. 36, page 130. The gage heights as published are the average of four daily readings reduced to feet and hundredths. Discharge measurements are made at the North Augusta highway bridge. Records of flow during 1899 will be found in the Twenty-first Annual Report, Part IV, page 135. During 1900 one measurement was made by B. M. Hall, as follows:

August 28: Gage height, 7.30 feet; discharge, 5,968 second-feet.

Daily gage height, in feet, of Savannah River at Augusta, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.12	6.87	17.37	9.98	11.50	7.70	14.46	11.29	7.37	6.18	7.20	7.95
2	6.94	6.81	23.12	9.89	11.20	7.50	12.90	9.46	7.79	6.38	7.30	7.50
3	6.67	6.44	13 87	9.54	10.70	7.50	12.25	8.30	8.35	6.38	7.70	7.75
4	6.42	6.52	14.06	9.54	12.30	8.30	11.66	7.76	7.33	6.16	13.80	9.18
5	6.50	8.33	11.44	9.65	10.60	10.20	10.60	7.73	7.00	6.40	12.00	15.31
6	6.67	9.10	10.60	9.63	9.60	9.50	9.62	7.38	6.85	6.65	9.30	14.44
7	6.39	8.89	10.37	9.20	9.30	11.70	9.27	7.27	6.44	7.65	8.00	11.22
8	6.65	8.08	10.64	9.00	9.00	19.70	8.96	7.19	6.20	7.41	7.70	9.32
9	6.71	8.12	17.35	8.75	9.00	19.90	8.79	7.13	6.27	7.35	7.50	8.50
10	6.71	10.04	17.60	8.90	8.80	19.90	8.39	7.09	5.89	7.50	7.40	8.40
11	7.12	20.58	14.35	9.15	8.70	10.80	8.52	7.06	6.16	6.30	6.90	8.06
12	10.40	27.19	12.21	11.10	8.60	9.50	8.22	6.57	6.06	6.75	7.00	7.90
13	15.00	29.60	10.96	11.35	8.40	9.20	8.68	6.62	6.08	6.85	7.10	7.80
14	12.79	32.31	10.39	10.77	8.30	9.30	8.94	7.31	5.99	7.48	7.00	8.80
15	9.37	30.08	10.08	9.47	8.30	9.90	9.60	7.17	7.40	7.14	7.00	11.56
16	8.65	22.08	15.25	9.16	8.20	9.70	9.37	6.77	14.49	6.62	6.80	9.81
17	8.12	16.29	17.27	8.88	7.80	15.00	8.64	7.67	14.24	6.56	6.80	8.60
18	7.67	12.75	14.21	12.15	8.40	19.80	8.37	7.27	10.60	6.47	6.50	7.97
19	7.94	11.39	11.42	23.89	9.70	18.40	8.19	6.78	8.35	6.45	6.80	7.44
20	8.94	10.46	13.68	24.70	11.00	13.50	8.04	6.82	7.70	6.27	7.20	8.15
21	10.26	10.35	15.25	24.25	10.60	10.70	7.89	6.62	7.27	5.95	7.50	12.10
22	10.44	14.79	13.70	26.73	8.90	9.60	7.39	6.48	7.12	6.30	7.40	12.70
23	9.11	15.44	11.85	24.73	8.40	11.70	8.00	6.50	6.92	6.32	7.30	11.12
24	8.44	12.89	11.73	18.27	10.40	21.80	8.20	6.56	6.35	12.66	7.40	9.35
25	8.12	12.96	14.10	14.75	13.00	29.20	8.92	6.77	6.75	16.72	7.00	9.40
26	7.96	12.37	19.65	17.08	11.00	26.80	8.32	7.77	6.50	12.30	10.00	9.20
27	7.73	10.96	18.37	13.73	9.10	23.00	9.23	7.12	6.67	10.60	14.90	8.72
28	7.19	10.31	14.79	12.50	8.50	19.60	11.12	7.20	6.46	9.72	11.80	8.40
29	7.22	.....	12.67	11.81	8.10	16.70	10.20	6.69	6.50	8.52	9.10	8.25
30	7.20	.....	11.46	11.20	7.90	14.60	11.88	6.62	6.19	7.95	8.30	8.40
31	7.08	.....	10.69	.....	7.80	.....	13.35	7.08	.....	7.60	.....	15.22

BROAD RIVER (OF GEORGIA) NEAR CARLTON, GEORGIA.

This station, established May 27, 1897, is located on the bridge of the Seaboard Air Line 3 miles east of Carlton, Georgia, and 3 miles above the mouth of the South Fork. A description of the station is given in Water-Supply Paper No. 36, page 131. The gage was last verified on October 17, 1900. Records of flow for 1899 will be found in the Twenty-first Annual Report, Part IV, page 132. During 1900 the following measurements were made by Max Hall:

February 16: Gage height, 4.25 feet; discharge, 2,088 second-feet.
March 30: Gage height, 3.30 feet; discharge, 1,480 second-feet.
May 3: Gage height, 4.49 feet; discharge, 2,562 second-feet.
October 17: Gage height, 2.22 feet; discharge, 661 second-feet.

Daily gage height, in feet, of Broad River (of Georgia) near Carlton, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	2.30	5.50	3.10	3.40	2.60	3.50	3.70	2.30	2.10	2.40	2.40
2	2.40	2.30	4.90	3.10	3.20	2.50	3.30	3.80	2.50	2.10	2.40	2.40
3	2.40	2.30	3.85	3.00	4.70	2.80	3.40	3.60	2.50	2.10	6.50	2.40
4	2.35	2.30	3.30	3.10	3.90	2.90	3.20	3.60	2.30	2.20	3.50	4.20
5	2.35	3.30	3.15	3.00	3.20	2.90	3.00	2.50	2.20	2.30	2.80	5.00
6	2.30	2.95	3.00	3.00	3.10	3.00	2.90	2.50	2.20	2.50	2.60	3.80
7	2.30	2.70	3.00	2.90	3.00	4.30	2.80	2.50	2.10	3.00	2.50	3.20
8	2.30	2.65	6.50	2.80	3.00	7.70	2.80	2.40	2.10	2.60	2.40	2.80
9	2.30	2.80	6.80	2.80	2.90	7.60	2.80	2.40	2.10	2.50	2.40	2.70
10	2.40	4.00	5.10	2.70	2.90	3.80	2.70	2.30	2.10	2.40	2.40	2.60
11	2.90	6.00	3.80	3.50	2.90	3.20	2.60	2.30	2.10	2.30	2.40	2.60
12	5.85	10.50	3.30	3.90	2.80	3.10	2.90	2.30	2.00	2.30	2.40	2.50
13	4.90	22.20	3.20	3.90	2.80	3.10	3.05	4.00	2.00	2.70	2.30	2.50
14	3.30	16.90	3.10	3.30	2.80	3.80	3.55	2.50	2.10	2.60	2.30	2.80
15	2.95	8.00	3.00	3.10	2.70	3.10	3.00	2.40	5.50	2.40	2.30	2.60
16	2.75	4.30	4.20	3.00	2.70	3.50	2.90	2.40	5.00	2.30	2.30	2.50
17	2.65	3.70	3.80	2.90	2.70	4.30	2.80	2.50	4.00	2.20	2.30	2.40
18	3.15	3.30	3.30	3.90	2.70	5.60	2.70	2.50	2.80	2.20	2.30	2.40
19	3.60	3.20	3.10	7.50	3.00	4.90	2.60	2.60	2.50	2.20	2.40	2.40
20	3.75	3.10	4.60	6.70	2.90	3.50	2.60	2.40	2.40	2.20	2.40	2.80
21	3.70	3.10	4.10	8.00	2.70	3.10	2.50	2.30	2.30	2.20	2.40	3.80
22	2.85	3.80	3.70	12.20	2.70	3.00	2.50	2.20	2.30	2.10	2.50	3.30
23	2.70	3.65	3.40	5.80	2.70	4.20	2.50	2.30	2.30	4.20	2.40	3.00
24	2.60	3.20	3.60	6.50	4.00	13.00	3.00	2.20	2.30	5.00	2.40	2.90
25	2.50	3.65	4.70	7.30	3.20	12.60	2.70	2.20	2.20	3.10	3.60	2.80
26	2.45	3.60	6.50	5.10	2.90	7.00	2.90	2.60	2.20	4.00	3.60	2.60
27	2.45	3.20	5.30	3.90	2.80	5.60	3.40	2.50	2.20	3.80	2.80	2.50
28	2.40	3.00	4.00	3.70	2.70	4.60	3.70	2.20	2.20	3.10	2.60	2.50
29	2.40	.....	3.50	3.50	2.70	4.00	3.40	2.20	2.20	2.70	2.50	2.50
30	2.35	.....	3.30	3.50	2.60	4.50	3.30	2.90	2.10	2.50	2.50	2.50
31	2.30	.....	3.25	.....	2.60	.....	3.90	2.20	.....	2.50	.....	3.80

OCONEE RIVER NEAR DUBLIN, GEORGIA.

This station was established by the United States Weather Bureau in 1894, was discontinued on April 30, 1897, and was reestablished by the Georgia geological survey on February 11, 1898. Since October 15, 1898, the station has been maintained by the United States Weather Bureau. It is located about a half mile east of Dublin, Georgia, and is described in Water-Supply Paper No. 36, page 133. Records of measurement will be found as follows: For 1898, Twentieth Annual Report, Part IV, page 170; for 1899, Twenty-first Annual Report, Part IV, page 136. During 1900 the following measurements of Oconee River at Dublin were made by B. M. Hall and his assistants:

April 12: Gage height, 4.25 feet; discharge, 4,680 second-feet.
December 7: Gage height, 7.30 feet; discharge, 7,991 second-feet.

Daily gage height, in feet, of Oconee River near Dublin, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	1.7	8.0	8.8	8.3	1.6	19.0	4.7	0.8	—0.1	1.0	2.3
2	2.1	1.6	9.6	6.5	6.4	1.4	16.9	5.0	2.7	— .3	.9	1.8
3	1.8	1.6	10.4	5.3	6.9	1.3	14.8	3.7	2.3	— .3	3.7	1.6
4	1.7	1.6	11.0	4.8	7.3	1.2	12.7	2.9	2.1	— .2	4.7	1.8
5	1.6	1.8	11.7	4.5	7.5	1.9	10.1	2.5	1.5	.0	5.5	3.2
6	1.6	3.4	11.0	4.3	6.7	2.8	8.5	1.9	1.2	.8	6.5	6.4
7	1.5	3.7	9.0	4.2	5.4	4.1	8.0	1.6	.5	1.2	6.6	7.2
8	1.4	3.5	6.6	4.0	4.1	5.0	5.5	1.6	.4	.9	4.8	7.6
9	1.2	3.1	5.8	3.7	3.9	6.0	3.9	1.5	.2	1.1	3.9	6.8
10	1.4	3.5	7.0	3.5	3.3	6.2	3.2	1.3	.2	1.2	2.6	4.5
11	1.9	7.9	8.0	3.3	3.0	6.2	2.6	.7	.0	1.0	1.8	3.3
12	2.4	10.2	8.5	3.9	2.7	5.7	2.8	.4	— .2	.8	1.3	2.7
13	4.3	11.9	8.7	5.0	2.5	4.3	6.6	.2	— .3	.6	1.2	2.3
14	5.4	16.4	8.0	5.9	2.3	3.0	6.1	.1	— .1	.7	1.0	2.3
15	5.7	22.0	7.1	6.3	2.2	2.9	5.5	.3	— .1	.6	1.0	5.2
16	4.9	24.4	6.4	5.0	2.1	5.0	4.7	1.1	.4	.6	.9	6.7
17	3.3	24.9	8.1	4.1	2.0	7.5	4.1	.8	4.8	.6	.8	8.1
18	2.9	24.1	8.7	3.4	1.9	8.3	2.8	.6	5.8	.5	.7	8.4
19	2.8	22.6	9.0	5.1	2.1	9.9	2.3	.5	6.0	.2	.9	6.4
20	3.2	20.0	9.1	8.2	3.7	10.3	2.0	.3	3.5	.1	.7	4.2
21	4.1	17.2	8.5	11.1	5.5	10.6	1.8	.1	1.9	.1	.7	4.6
22	4.7	14.0	7.4	15.6	5.3	10.2	1.5	.5	1.3	.0	1.1	6.8
23	4.4	10.7	7.8	16.9	3.6	7.9	1.2	.5	.7	.0	1.2	7.7
24	3.9	9.1	8.3	17.6	3.1	8.0	1.0	.4	.4	.7	.8	8.0
25	3.3	9.0	8.9	17.3	3.6	9.0	2.4	.8	.3	3.7	.8	8.2
26	2.9	8.7	9.5	17.0	5.8	9.9	3.1	1.3	.3	5.6	.7	6.5
27	2.4	8.1	9.6	17.1	5.0	11.6	2.1	.9	.3	5.5	1.7	4.8
28	2.2	7.4	9.8	16.0	3.4	16.7	1.7	.7	.2	3.0	3.5	3.8
29	2.0	.....	10.2	13.6	3.0	20.0	1.7	.5	.2	2.1	5.3	3.4
30	1.8	.....	10.4	11.4	2.2	20.8	5.9	.5	0.0	1.9	3.4	3.3
31	1.7	.....	10.2	.....	1.9	.....	5.2	.8	.....	1.3	.....	3.4

YELLOW RIVER AT ALMON, GEORGIA.

This station, which was established September 12, 1897, is described in Water-Supply Paper No. 36, page 134. During the year 1900 the bridge was washed away and a new bridge was built, but the gage was preserved and a new gage was referred to the same datum. It is attached to the post of a bridge bent near the left bank, and is referred to a bench mark on a sycamore tree on the left bank 40 yards above the bridge, a railroad spike in the tree being 7 feet above the zero of the gage. The gage was verified December 22, 1900. Records of measurements at this station during 1899 will be found in the Twenty-first Annual Report, Part IV, page 137. During 1900 the following measurements of the discharge at Almon were made by B. M. Hall and his assistants:

April 19: Gage height, 9 feet; discharge, 3,295 second-feet.
November 30: Gage height, 2.40 feet; discharge, 341 second-feet.
December 22: Gage height, 4.50 feet; discharge, 966 second-feet.

Daily gage height, in feet, of Yellow River at Almon, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.1	2.0	4.5	3.1	3.7	2.4	4.0	3.4	3.0	2.0	2.0	2.4
2	1.9	2.0	4.5	3.0	3.8	2.4	5.0	2.7	3.0	2.0	2.0	2.3
3	1.9	2.0	3.5	3.0	7.2	2.4	5.0	2.5	2.5	2.0	2.0	2.3
4	1.9	2.0	3.4	3.0	6.9	2.4	4.7	2.3	2.3	2.5	4.3	7.5
5	2.0	2.5	3.2	3.0	4.0	3.4	4.0	2.3	2.1	2.5	4.0	7.0
6	2.0	2.7	3.0	3.0	3.6	4.0	3.5	2.2	2.1	2.8	3.0	5.0
7	2.0	2.5	3.0	2.9	3.4	3.4	3.0	2.1	2.0	3.5	2.5	3.5
8	2.0	2.5	4.7	2.9	3.2	6.7	3.0	2.0	2.0	4.0	2.0	3.0
9	2.0	3.5	10.0	2.9	3.1	4.4	3.0	2.0	2.0	3.0	2.0	2.9
10	2.3	5.7	6.0	2.9	3.0	3.3	3.0	2.0	2.0	2.7	2.0	2.8
11	2.9	5.9	4.0	3.9	3.0	3.1	3.0	1.9	2.0	2.4	2.0	2.8
12	4.4	15.0	3.8	4.7	3.0	2.9	3.0	1.9	2.0	2.4	2.0	2.9
13	3.5	20.0	3.6	4.0	2.9	2.8	3.0	1.9	2.0	2.4	2.0	2.7
14	3.0	15.0	3.4	3.4	2.8	3.2	3.0	1.9	3.0	2.3	2.0	4.0
15	2.5	7.0	3.3	3.0	2.8	3.0	3.0	2.5	3.0	2.3	2.0	3.5
16	2.5	5.0	3.8	2.0	2.8	4.0	2.8	2.3	7.0	2.2	2.0	3.2
17	2.4	4.9	3.4	3.0	2.8	6.0	2.7	2.2	4.0	2.1	2.0	3.0
18	3.4	4.7	3.0	8.0	2.7	5.0	2.6	2.0	3.0	2.0	2.0	2.8
19	4.0	3.6	3.4	9.0	3.5	4.0	2.5	2.0	2.5	2.0	2.0	2.8
20	4.3	4.7	5.0	6.8	2.8	3.5	2.0	2.0	2.0	2.0	2.0	5.0
21	3.6	3.9	4.3	12.0	2.8	3.2	2.0	2.0	2.0	2.0	2.0	6.5
22	3.0	3.8	3.7	10.0	2.6	3.0	2.0	2.5	2.0	2.0	2.0	4.5
23	2.8	3.7	3.4	6.0	2.6	7.5	2.0	2.5	2.0	3.0	2.0	3.5
24	2.6	3.7	3.7	7.2	4.0	11.0	2.0	2.4	2.0	3.0	2.0	3.5
25	2.5	3.7	5.5	12.0	3.0	11.0	2.5	2.3	2.0	2.5	2.0	3.5
26	2.4	3.8	8.0	6.8	2.8	12.0	2.0	2.0	2.0	2.3	4.5	3.0
27	2.3	3.8	6.0	6.0	2.6	9.0	3.0	2.0	2.0	2.0	3.5	3.0
28	2.2	3.8	4.4	5.8	2.4	9.5	3.5	2.0	2.0	2.0	2.5	2.9
29	2.1	.....	4.0	5.4	2.4	6.3	3.5	2.0	2.0	2.0	2.4	2.9
30	2.0	.....	3.5	4.3	2.4	5.0	5.0	2.0	2.0	2.0	2.4	4.0
31	2.0	.....	3.2	.....	2.4	.....	4.0	5.0	.....	2.0	.....	7.5

TOWALIGA RIVER NEAR JULIETTE, GEORGIA.

This station was established on the Southern Railway bridge 2½ miles north of Juliette, Georgia, May 5, 1899, but observations of gage heights were not started until November 2, 1899. A description of the station will be found in Water-Supply Paper No. 36, page 136. Bench mark No. 1 is an iron girder 40 feet from the left end of the bridge and is 37.30 feet above gage datum. W. L. Jackson, a farmer living near the station (post-office address, Berner, Georgia), is the observer. Records of measurements made during 1899 will be found in Water-Supply Paper No. 36, page 136. During 1900 the following measurements were made by B. M. Hall and his assistants:

February 17: Gage height, 6.35 feet; discharge, 1,025 second-feet.
April 3: Gage height, 2.60 feet; discharge, 348 second-feet.
December 8: Gage height, 2.75 feet; discharge, 468 second-feet.

Daily gage height, in feet, of Towaliga River near Juliette, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.2	2.0	2.9	1.8	3.1	2.0	4.0	2.2	4.5	0.9	1.3	1.9
2	2.2	1.9	4.3	1.6	3.6	2.1	4.0	2.2	1.5	1.0	2.0	1.9
3	2.0	1.9	3.1	2.6	4.9	2.1	3.5	1.7	1.9	1.4	8.2	4.7
4	2.0	2.1	2.8	2.8	3.3	3.7	3.5	1.7	1.6	2.1	7.0	4.0
5	1.9	2.7	2.4	2.6	3.1	2.9	4.1	2.3	1.5	3.4	6.4	3.4
6	1.9	2.6	2.4	2.5	2.6	2.5	3.5	1.7	1.3	3.6	3.5	3.0
7	1.9	2.3	1.4	2.7	2.6	3.2	3.3	1.5	1.2	3.9	2.2	3.0
8	1.9	1.4	2.9	2.6	2.5	5.2	4.2	1.3	1.0	3.8	2.1	2.4
9	1.9	2.4	3.4	2.5	2.5	2.4	4.0	1.2	1.0	1.7	2.1	2.4
10	1.9	7.3	2.8	2.5	2.5	2.6	4.0	1.2	1.0	1.5	2.0	2.3
11	1.9	11.8	2.3	3.4	2.4	2.9	3.8	1.2	1.0	1.5	2.0	2.0
12	2.7	14.1	1.3	5.7	2.4	2.3	3.7	1.1	1.0	1.6	1.9	2.0
13	2.8	14.8	2.0	4.0	2.4	2.3	4.4	1.3	1.0	1.7	1.9	2.3
14	2.3	16.3	1.1	2.9	2.3	2.4	3.7	1.0	2.4	1.7	1.9	9.0
15	2.2	16.3	1.0	2.8	2.3	2.3	2.2	1.7	8.0	1.5	1.9	7.4
16	2.1	8.3	4.0	2.7	2.2	2.9	2.0	1.5	6.4	1.4	1.8	4.0
17	2.0	4.8	3.1	2.7	2.2	3.3	1.8	1.3	4.2	1.3	1.8	3.6
18	2.1	3.8	2.3	12.8	2.2	3.8	1.0	1.9	3.1	1.1	1.8	3.0
19	2.8	3.3	1.1	17.8	2.2	4.1	1.0	1.3	2.9	1.1	2.0	2.6
20	3.2	3.2	3.3	14.8	2.2	5.2	1.0	1.2	2.0	1.1	1.9	6.4
21	2.9	2.4	3.1	7.8	2.2	2.2	1.0	1.1	1.4	1.1	1.8	7.5
22	2.5	4.0	2.3	12.8	2.1	1.9	1.5	0.8	1.3	1.1	1.8	5.5
23	2.3	3.3	2.2	5.5	2.1	2.2	1.5	0.9	1.2	2.4	1.9	3.5
24	2.2	2.9	2.7	4.8	2.8	9.8	2.2	2.1	1.3	3.6	1.9	3.5
25	2.2	2.4	3.4	4.1	2.9	10.8	1.9	3.0	1.3	3.5	2.5	2.8
26	2.1	3.0	4.0	3.6	2.5	8.8	1.6	4.3	1.2	2.9	4.4	2.7
27	2.0	2.9	3.6	3.4	2.4	6.8	2.4	2.6	1.2	2.1	3.1	2.5
28	2.1	2.4	2.8	3.2	2.4	6.6	2.5	1.5	1.1	1.5	2.4	2.5
29	2.0	.....	2.4	3.3	2.2	6.2	4.0	1.2	1.1	1.3	2.3	2.3
30	2.0	.....	2.4	3.2	2.1	4.2	5.1	1.6	0.8	1.2	1.9	3.4
31	2.1	.....	2.1	.....	2.1	.....	3.4	5.5	.....	1.2	.....	4.3

OCMULGEE RIVER AT MACON, GEORGIA.

This station was established by the United States Weather Bureau January 21, 1893, and measurements were begun by the United States Geological Survey in 1895. The station is described in Water-Supply Paper No. 36, page 136. During the year 1900 Mr. T. S. Collins, of the United States Weather Bureau, put in a new gage on the center pier of the bridge on which the old gage was placed, and referred it to the same datum as the old gage. The old gage is still in place, is in good condition, and is still used except during low water, when mud accumulates around its base at a higher level than the river. The new gage was put in to save cleaning away the mud from the bottom of the old gage. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 139. During 1900 the following measurements were made by B. M. Hall and his assistants:

April 13: Gage height, 7.38 feet; discharge, 4,855 second-feet.
November 20: Gage height, 2.40 feet: discharge, 1,369 second-feet.
December 6: Gage height, 8.65 feet; discharge, 5,698 second-feet.
December 21: Gage height, 12.82 feet; discharge, 9,621 second-feet.

Daily gage height, in feet, of Ocmulgee River at Macon, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.6	1.6	9.2	5.2	6.1	2.9	9.6	6.1	10.5	1.8	2.0	2.7
2	1.5	1.5	9.4	4.9	7.3	2.9	8.3	4.4	5.8	1.8	3.2	2.6
3	1.2	1.5	7.7	4.8	8.6	3.2	13.3	4.2	5.0	1.7	2.8	2.5
4	1.2	1.5	6.2	4.6	8.0	3.8	11.2	3.7	3.5	2.2	12.3	8.4
5	1.2	2.8	5.8	4.5	7.3	4.6	8.3	3.4	2.7	4.1	8.2	11.5
6	1.5	2.9	5.5	4.5	6.4	6.4	6.4	3.1	2.5	3.6	4.9	9.3
7	1.4	2.5	5.3	4.3	5.6	8.0	5.5	3.0	2.4	5.0	3.6	6.4
8	1.4	2.3	7.0	4.3	4.4	8.9	4.9	2.8	2.1	4.6	3.2	4.8
9	1.3	3.2	7.8	4.1	4.1	7.7	5.0	2.6	2.2	2.7	2.8	4.2
10	1.3	8.3	9.7	4.1	4.1	6.6	4.5	2.5	2.1	3.2	2.6	3.7
11	1.9	16.1	8.1	4.3	4.1	5.5	4.3	2.4	2.0	2.6	2.5	3.3
12	2.9	18.7	6.4	7.0	4.0	5.2	4.8	2.3	2.0	2.5	2.4	3.2
13	4.2	19.0	5.8	7.6	3.9	3.8	5.3	2.4	1.8	2.4	2.3	3.0
14	3.7	21.7	5.3	6.1	3.8	3.7	4.9	2.6	1.7	2.7	2.2	8.5
15	2.6	19.5	5.3	5.3	3.6	3.2	4.5	2.4	4.7	2.6	2.2	12.5
16	2.2	15.5	10.4	4.8	3.4	8.6	4.0	2.4	13.3	2.4	2.2	8.5
17	2.0	11.4	7.3	4.3	3.4	8.8	3.9	2.6	10.5	2.2	2.1	4.6
18	2.0	8.5	5.8	5.0	3.3	10.9	3.7	2.7	6.0	2.1	2.1	4.4
19	2.9	7.4	5.2	18.0	4.1	11.2	3.5	2.7	4.0	2.0	2.1	3.9
20	3.8	6.8	8.0	15.6	4.0	8.0	3.5	2.6	3.3	1.9	2.0	4.0
21	4.6	8.2	7.7	13.9	3.7	5.3	3.4	2.4	2.7	1.9	2.4	12.8
22	3.9	8.9	6.6	16.0	3.5	4.0	3.3	2.3	2.5	1.9	2.4	12.1
23	3.1	7.7	5.6	13.9	3.3	4.0	3.4	2.2	2.4	2.1	2.5	8.6
24	2.7	6.4	7.3	13.2	4.6	16.0	3.9	3.6	2.3	8.3	2.7	6.5
25	2.5	7.3	7.9	13.0	4.8	20.2	3.4	4.1	2.3	4.2	2.5	5.5
26	2.2	6.5	10.5	12.4	4.2	20.0	3.3	4.3	2.2	3.7	7.1	4.8
27	2.0	5.9	10.9	9.8	3.8	16.4	4.2	3.8	2.0	2.9	5.5	4.1
28	2.0	5.5	7.8	7.6	3.3	14.0	4.5	2.7	2.0	2.5	4.3	3.9
29	1.9	.....	7.4	7.0	3.1	12.7	5.6	2.4	2.0	2.4	3.2	3.7
30	1.7	.....	6.6	6.3	3.0	10.4	6.3	2.3	1.9	2.3	2.9	3.8
31	1.6	.....	5.8	.....	2.9	.....	8.0	3.8	.....	2.1	.....	7.5

FLINT RIVER AT ALBANY, GEORGIA.

This station, which is described in Water-Supply Paper No. 36, page 138, was originally established by the United States Weather Bureau on April 10, 1893, and has been maintained from that date to the present time. In 1898 the gage was washed out by a freshet, but soon afterwards it was replaced. The present rod is located at the foot of Broad street, just below the county bridge. It is a pine board, and is in two sections. The first section, which reads from 0 to 18.6 feet, is spiked to a cypress stump which stands at the edge of the water; the second section, which reads from 18.7 feet to 30 feet, is spiked to a cypress pole. The bench marks are as follows: (1) The top of the rail at the railroad station of the Plant System, being 42.2 feet above the zero of the gage and 184 feet above mean sea level, making the elevation of the zero of the rod 141.8 feet above sea level; (2) a cut in the lower iron pier of the county bridge 10 feet above gage datum and 151.8 feet above mean sea level; and (3) a spike in the corner of Mase & Company's warehouse, corner of Broad and Front streets, 53.8 feet above gage datum. The highest water recorded was on March 25, 1897, when the height of 31.6 feet was reached, and the lowest point recorded since the commencement of the record was on October 9, 1895, when the reading was —0.9 foot. The danger line is at 20 feet. Discharge measurements are made at the county highway bridge in Albany, a steel structure in two spans of 130 feet each, with two approaches of 315 and 205 feet, respectively.

Kinchafoonee and Muckalee creeks are two important tributaries of Flint River. They unite about 2 miles north of Albany, forming Big Muckalee Creek, which enters Flint River on the west side within the city limits. There is a wagon bridge over the Kinchafoonee about 1 mile above its junction with the Muckalee, and a similar bridge on the Muckalee 1¾ miles above its mouth and about 300 yards below the mouth of the Kinchafoonee. Measurements will be made at these bridges whenever Flint River is measured at Albany. No discharge measurements were made at this point during 1900 or in previous years, but measurements will be made during 1901.

Daily gage height, in feet, of Flint River at Albany, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.7	1.8	9.1	11.1	9.4	1.1	15.8	4.2	1.3	0.9	3.0	2.5
2	4.3	1.9	9.2	10.0	10.2	1.3	16.0	4.2	1.5	1.0	3.4	1.9
3	3.0	2.3	9.3	9.1	11.1	1.3	16.0	3.8	1.9	1.0	3.7	1.8
4	3.3	2.3	9.5	8.3	11.0	1.2	15.2	3.4	2.4	1.2	3.9	2.3
5	2.9	2.6	9.6	7.2	10.3	1.4	13.0	2.8	2.9	1.6	4.6	2.7
6	2.6	2.9	9.3	6.1	9.7	1.7	10.3	2.2	3.4	1.9	5.7	2.9
7	2.3	3.4	9.2	5.9	6.2	2.1	2.0	1.6	3.7	2.1	4.8	3.4
8	1.7	3.8	8.9	5.4	4.7	2.5	6.1	1.0	3.7	2.9	4.9	3.8
9	1.3	4.8	9.1	4.7	3.8	2.9	5.3	.8	3.8	3.1	5.6	4.1
10	1.2	6.4	9.2	4.3	3.9	3.5	4.9	1.2	3.6	3.1	3.7	4.7
11	1.2	9.8	9.1	4.3	4.5	3.5	4.0	1.0	3.7	3.1	2.9	5.2
12	1.7	14.3	9.0	4.3	4.9	3.6	3.8	.8	3.6	3.7	2.1	6.1
13	2.3	18.1	8.9	4.5	5.2	3.8	4.4	.8	3.7	3.9	1.7	6.9
14	2.8	20.0	8.9	4.7	5.2	4.3	4.9	.8	3.9	4.1	1.3	7.1
15	3.3	21.3	9.7	4.9	5.1	3.4	5.0	.9	4.3	4.5	1.2	7.1
16	3.1	22.4	10.5	5.4	4.6	2.0	5.4	.8	4.5	4.2	1.2	7.4
17	2.9	26.2	10.8	5.9	4.1	2.1	5.8	1.0	4.6	4.2	1.1	7.4
18	2.8	29.0	11.2	7.8	3.8	2.4	4.6	1.2	4.6	4.3	.9	7.8
19	2.8	29.0	11.2	8.6	3.1	2.4	3.1	1.2	4.3	4.3	.9	8.2
20	2.9	28.1	12.1	10.7	2.6	2.4	2.4	1.3	4.1	4.2	.9	8.5
21	3.0	26.4	12.2	11.2	2.4	2.5	1.6	1.4	3.7	4.3	1.0	8.9
22	3.3	23.1	12.1	12.1	2.0	2.8	1.4	1.2	3.5	4.3	1.3	8.9
23	3.4	21.0	12.1	13.6	2.0	2.9	1.5	1.0	3.5	4.4	1.4	9.1
24	3.7	17.2	12.2	14.3	1.9	3.3	1.6	.9	3.1	4.5	1.5	9.0
25	3.5	13.3	12.2	14.9	1.7	3.9	1.4	.9	2.7	4.2	1.7	9.0
26	3.1	11.2	16.3	15.2	1.4	4.2	1.7	.9	2.3	4.0	2.2	8.7
27	2.5	9.0	16.9	12.1	1.3	5.3	1.6	.8	1.1	3.7	2.4	8.6
28	2.2	9.0	16.0	11.3	1.2	7.5	1.9	.8	1.0	3.6	2.7	8.4
29	2.0	.....	15.1	9.0	1.2	8.2	2.7	.9	1.0	3.4	2.7	8.9
30	1.9	.....	13.4	8.9	1.0	12.5	2.9	.9	.9	3.2	2.8	9.4
31	1.3	.....	11.6	.....	1.0	.....	3.9	1.1	.....	3.1	.....	10.3

FLINT RIVER AT WOODBURY, GEORGIA.

Measurements of the flow of Flint River were made during 1897 and 1898 at Molina, Georgia, but the river bed was so shifting that the station was discontinued on June 2, 1898. Records of the measurements made at Molina will be found as follows: For 1897, Nineteenth Annual Report, Part IV, page 234; for 1898, Twentieth Annual Report, Part IV, page 233. A gage has been maintained at Albany, Georgia, by the United States Weather Bureau, as described in Water-Supply Paper No. 36, page 138. Two measurements were made in 1899 at the Macon and Birmingham bridge near Woodbury, Georgia, 5 miles below the Molina station. On March 29, 1900, a gage was put in near this bridge, and the station was reestablished. The gage is a vertical rod fastened to a willow tree on the left bank of the river about 300 feet above the bridge, and is referred to the bench mark

(the top of the iron girder under the cross-ties at a point 12 feet to the left of the center pier), which is 27 feet above the zero of the gage, the zero of the gage being 659.6 feet above sea level. This gage was maintained by the Georgia geological survey until November 1, 1900, when it was adopted by the United States Weather Bureau as a half-year station, instead of the one at Reynolds, Georgia. During 1900 the following measurements were made by B. M. Hall and his assistants:

March 29: Gage height, 2.20 feet; discharge, 2,829 second-feet.
May 2: Gage height, 2.85 feet; discharge, 3,220 second-feet.
December 12: Gage height, 0.85 foot; discharge, 998 second-feet.
December 21: Gage height, 4.85 feet; discharge, 5,428 second-feet.

Daily gage height, in feet, of Flint River at Woodbury, Georgia, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.3	1.9	0.6	2.9	2.5	0.4	0.2	0.4	0.7
2	.....	1.2	1.5	.5	2.8	1.7	.7	.1	1.2	.6
3	.....	1.2	1.3	.6	4.5	1.2	.6	.2	2.0	.5
4	.....	1.1	1.4	1.0	4.3	1.0	.4	.5	3.3	1.8
5	.....	1.1	1.2	1.4	3.7	1.2	.3	1.5	2.8	2.3
6	.....	1.1	1.0	1.6	2.4	.8	.2	1.8	1.3	2.1
7	.....	1.0	.9	1.5	1.8	.6	.2	1.2	1.0	1.8
8	.....	1.0	.8	1.4	1.4	.5	.2	1.0	.8	1.4
9	.....	1.0	.7	1.8	1.1	.4	.1	1.8	.7	1.3
10	.....	1.2	.8	1.8	1.0	.4	.1	.7	.6	1.0
11	.....	1.3	.6	1.6	.9	.3	.2	.5	.5	.9
12	.....	2.1	.7	1.0	1.6	.3	.2	.5	.6	.8
13	.....	2.4	.7	.7	1.5	.7	.1	.6	.5	.8
14	.....	2.1	.6	.6	1.6	.4	.1	.6	.5	2.4
15	.....	1.6	.6	.5	1.3	.3	1.3	.5	.5	3.3
16	.....	1.4	.5	1.0	1.0	.4	1.6	.4	.4	2.7
17	.....	1.2	.6	4.1	.8	.4	1.5	.4	.5	2.1
18	.....	2.0	.5	4.0	.7	.5	1.3	.3	.5	1.6
19	.....	4.6	1.0	3.8	.6	.4	1.1	.2	.6	1.3
20	.....	5.2	.8	6.0	.5	.3	.8	.2	.5	2.1
21	.....	5.8	.7	5.0	.8	.3	.4	.3	.6	4.3
22	.....	5.0	.6	2.4	.6	.2	.3	.3	.7	3.9
23	.....	2.8	.5	2.0	.5	.1	.3	.6	.6	3.5
24	.....	2.6	1.0	9.0	1.1	.2	.2	.9	.7	2.8
25	.....	2.4	1.5	8.5	.8	.1	.3	1.0	.7	2.1
26	.....	2.2	1.3	8.0	1.0	.3	.2	1.1	1.5	1.7
27	.....	1.9	.9	7.0	1.2	.3	.2	.7	1.6	1.4
28	.....	1.7	.7	5.9	1.2	.2	.2	.5	1.2	1.3
29	2.2	1.5	.6	5.1	1.6	.2	.2	.4	1.0	1.2
30	1.9	1.2	.5	4.1	2.4	.3	.1	.4	.8	1.3
31	1.6	.....	.5	.....	3.0	.4	.....	.3	.....	2.2

CHATTAHOOCHEE RIVER AT OAKDALE, GEORGIA.

Two gaging stations are maintained on Chattahoochee River, one at Oakdale, 8 miles northwest of Atlanta, and the other at West Point, Georgia, where the river reaches the Alabama State line. The station at Oakdale was established October 17, 1895, and is described in Water-Supply Paper No. 36, page 139. The results of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 140. During 1900 the following measurements were made by B. M. Hall and his assistants:

January 4: Gage height, 1.53 feet; discharge, 1,784 second-feet.
March 27: Gage height, 5.85 feet; discharge, 5,504 second-feet.
July 6: Gage height, 4 feet; discharge, 3,886 second-feet.
September 12: Gage height, 1.08 feet; discharge, 1,456 second-feet.
November 29: Gage height, 2.32 feet; discharge, 2,334 second-feet.

Daily gage height, in feet, of Chattahoochee River at Oakdale, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.0	4.5	3.4	5.0	3.0	5.0	5.0	2.0	2.1	2.4	2.2
2	.7	1.0	5.9	3.1	4.8	3.7	4.5	4.5	2.0	2.1	2.4	2.2
3	.5	.9	4.3	3.0	4.5	4.0	6.0	4.0	2.0	2.1	3.0	2.1
4	.5	.9	3.6	2.7	4.0	4.7	7.5	4.0	1.9	3.0	2.8	2.3
5	.9	2.9	3.3	2.7	3.9	4.0	7.0	4.0	1.7	3.4	2.7	4.1
6	1.2	3.5	3.1	2.8	3.0	3.8	6.5	3.5	1.8	3.8	2.5	4.0
7	1.3	2.2	3.0	2.8	3.0	4.7	6.4	3.5	1.8	4.0	2.5	4.0
8	1.3	1.9	8.8	2.7	3.0	9.7	6.0	3.5	1.8	4.0	2.5	3.8
9	1.2	3.8	7.9	2.7	2.9	10.5	5.8	3.0	1.7	3.9	2.4	3.7
10	1.1	4.3	6.9	2.6	2.9	8.0	5.7	3.0	1.7	3.5	2.4	3.5
11	2.0	7.4	5.5	3.0	2.8	5.0	5.6	3.0	1.5	3.5	2.4	2.1
12	3.9	8.0	4.0	6.4	2.7	4.0	5.4	3.0	1.5	3.9	2.4	2.0
13	3.0	15.5	3.1	5.4	2.7	4.5	5.2	3.0	4.3	4.3	2.3	2.0
14	2.8	20.7	3.2	4.2	2.6	4.0	5.0	3.0	8.4	4.2	2.2	2.3
15	2.2	16.4	3.0	3.8	2.6	3.5	4.5	3.0	10.2	4.0	2.1	2.3
16	1.9	6.0	5.0	3.3	2.6	3.0	4.4	2.7	8.2	3.6	2.1	2.2
17	1.7	4.8	3.6	4.0	2.5	3.5	4.3	3.0	6.0	3.4	2.0	2.1
18	1.8	3.8	3.0	6.9	3.5	4.5	4.2	4.0	3.1	3.2	2.0	2.1
19	2.9	3.5	4.5	9.0	3.7	6.0	4.1	3.5	3.0	3.0	1.8	2.0
20	4.0	3.1	5.9	7.3	3.0	6.5	4.0	3.5	2.8	3.0	1.5	2.3
21	5.8	3.0	6.6	6.3	3.1	8.0	3.9	3.0	2.8	2.8	1.5	2.6
22	4.8	4.2	4.8	7.0	3.2	9.0	3.8	3.0	2.7	3.0	1.8	2.8
23	2.9	4.3	4.1	6.3	3.7	13.6	3.7	3.0	2.5	3.3	2.0	2.7
24	3.0	3.8	3.5	13.6	3.9	18.0	3.7	3.0	2.3	3.3	1.9	3.0
25	2.6	4.1	7.7	7.5	3.7	17.5	4.0	2.7	2.3	3.0	1.8	2.8
26	1.9	4.0	7.5	6.0	3.5	11.4	5.0	2.7	2.0	3.0	1.8	2.7
27	1.7	3.3	6.0	5.5	3.4	10.5	6.0	2.6	2.0	2.9	5.6	2.5
28	1.5	3.0	4.5	5.0	3.2	7.5	6.5	2.5	1.8	2.8	3.3	2.3
29	1.5	.....	4.0	5.0	3.0	6.0	7.4	3.0	1.5	2.6	2.3	2.3
30	1.4	.....	3.8	5.0	2.5	5.5	10.0	3.0	1.5	2.4	2.0	3.0
31	1.3	.....	3.5	.....	2.4	.....	6.0	2.7	.....	2.4	.....	3.8

CHATTAHOOCHEE RIVER AT WEST POINT, GEORGIA.

This station was established July 30, 1896, on the highway bridge in West Point, Georgia, about 500 feet below the railroad bridge. It is described in Water-Supply Paper No. 36, page 142. The gage was last verified December 4, 1900. The observer is C. E. Melton. The results of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 141. During 1900 the following measurements were made by B. M. Hall and his assistants:

January 20: Gage height, 4.65 feet; discharge, 6,574 second-feet.
February 24: Gage height, 4.92 feet; discharge, 7,158 second-feet.
August 22: Gage height, 2.80 feet; discharge, 2,755 second-feet.
December 4: Gage height, 3.93 feet; discharge, 5,224 second-feet.

Daily gage height, in feet, of Chattahoochee River at West Point, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.80	5.90	4.10	4.90	3.40	6.30	6.40	4.10	2.60	2.80	3.70
2	2.80	2.60	4.70	4.10	4.80	3.30	9.40	5.70	6.10	2.50	2.70	3.20
3	2.50	2.40	4.60	4.05	4.60	3.30	7.80	5.00	4.50	2.50	4.60	3.10
4	2.50	3.00	5.00	4.05	4.40	3.60	7.00	4.50	3.20	2.60	4.20	3.90
5	2.40	3.00	4.80	4.00	4.30	5.00	6.50	4.00	3.00	3.80	4.30	4.50
6	2.80	4.60	4.50	3.95	4.20	4.80	6.20	3.60	2.90	4.00	3.60	5.80
7	2.90	4.50	4.20	3.90	4.00	4.30	5.40	3.40	2.80	4.20	3.40	5.90
8	2.80	4.20	5.00	3.90	3.80	5.10	5.00	3.20	2.70	3.70	3.20	4.60
9	2.80	4.60	8.10	3.85	3.60	8.10	5.10	3.10	2.60	3.50	3.10	3.90
10	2.70	7.30	7.50	3.80	3.60	8.50	4.20	3.00	2.50	3.40	3.00	3.60
11	3.40	8.60	6.30	4.90	3.50	5.80	4.00	2.90	2.40	3.40	3.00	3.30
12	4.70	12.20	5.60	6.10	3.40	4.60	3.60	2.80	2.30	3.60	2.90	3.20
13	4.40	19.12	4.70	6.70	3.40	6.50	5.40	3.40	2.20	3.80	2.90	3.10
14	4.70	19.50	4.50	6.00	3.40	3.90	5.00	3.80	2.30	3.70	2.80	4.90
15	4.90	18.50	4.30	5.50	3.30	4.20	4.80	3.00	9.20	3.20	2.80	4.20
16	4.60	12.40	4.50	4.20	3.30	6.40	4.50	3.00	12.60	3.00	2.70	3.70
17	3.70	5.90	4.30	4.00	3.20	6.00	4.30	2.90	8.80	3.00	2.70	3.50
18	3.40	5.50	4.10	6.00	3.20	7.00	4.10	2.90	8.00	2.90	2.70	3.30
19	3.90	4.70	5.00	7.70	3.70	8.40	4.00	2.80	5.70	2.90	2.70	3.00
20	4.60	4.50	5.20	8.50	3.60	6.00	3.80	2.80	4.30	2.80	2.70	5.80
21	4.80	4.60	5.20	7.40	3.50	4.50	3.60	2.80	3.20	2.80	2.60	6.50
22	5.10	4.60	6.30	7.00	3.40	3.80	3.50	2.80	3.00	3.00	2.80	6.40
23	4.20	4.70	6.20	7.50	3.40	4.60	3.80	2.90	2.90	4.60	2.90	6.00
24	3.80	4.80	5.80	7.00	5.00	16.40	3.70	3.50	2.80	5.00	3.00	5.30
25	3.70	4.80	6.10	9.20	4.40	17.80	3.60	3.80	2.80	4.90	3.20	4.80
26	3.30	5.00	6.50	8.00	4.20	14.60	3.60	3.40	2.70	3.40	3.80	4.20
27	3.20	4.60	5.80	6.00	4.00	12.20	4.00	3.20	2.70	3.20	4.50	4.10
28	3.00	4.90	5.40	4.80	3.60	8.40	6.10	3.00	2.70	3.00	4.00	3.90
29	3.00	.....	5.30	4.50	3.50	5.60	6.70	2.90	2.60	2.90	5.00	3.60
30	2.90	.....	5.10	5.20	3.40	6.70	12.60	3.30	2.60	2.80	4.60	3.80
31	2.90	.....	4.50	.....	3.40	.....	9.20	3.90	.....	2.80	.....	7.20

ETOWAH RIVER AT CANTON, GEORGIA.

This station was established by the United States Weather Bureau March 12, 1892. It is located on the iron highway bridge about 1,000 feet north of the Atlanta, Knoxville and Northern Railway station at Canton and about a half mile north of Canton Creek. The gage is a vertical timber attached to the upstream side of the left-bank pier of the bridge, and is graduated to feet and tenths. Owing to high water at the time the gage was put in it was set 1 foot higher than intended. Recognizing the error, the gage-height records were begun by adding 1 foot to the actual readings. It was the intention to lower the gage as soon as the water went down, but this has not been done, so that all of the gage heights and discharge measurements have been based on the rod with the zero point set 1 foot lower than the actual rod. The gage will probably be lowered to its proper place during the year 1901. This station is described in Water-Supply Paper No. 36, page 143. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 145. During 1900 the following measurements were made by B. M. Hall and his assistants:

February 27: Gage height, 0.80 foot; discharge, 1,113 second-feet.
May 19: Gage height, 1.05 feet; discharge, 1,351 second-feet.
December 1: Gage height, 0.55 foot; discharge, 816 second-feet.

Daily gage height, in feet, of Etowah River at Canton, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.6	0.6	0.8	1.4	1.2	1.4	1.7	1.0	0.6	0.3	1.3	0.6
2	.6	.8	.8	1.0	1.2	1.4	1.7	1.0	.6	.2	1.4	.6
3	.6	1.0	.8	.8	1.2	2.4	1.8	1.0	.6	.2	1.6	.5
4	.6	1.0	.8	.8	1.2	2.0	1.8	1.0	.6	1.6	1.6	2.8
5	.6	1.2	.8	.8	1.1	3.0	1.8	1.0	.6	1.5	1.4	2.6
6	.6	1.2	.8	.8	1.1	3.0	2.4	.8	.6	1.3	1.4	1.3
7	.6	1.2	.8	.8	1.1	6.0	2.2	.8	.6	1.3	1.4	1.0
8	.6	2.7	3.4	.8	1.1	6.0	1.8	.8	.6	2.2	1.4	.8
9	.6	2.5	5.4	.8	1.1	4.0	1.3	.8	.6	3.1	1.4	.8
10	.6	1.8	2.2	.8	1.0	(a)	1.2	.6	.6	2.0	1.4	.7
11	.6	2.7	1.6	.8	1.0	(a)	1.0	.6	.6	2.0	1.4	.6
12	1.6	14.2	1.0	2.3	1.0	(a)	1.0	.6	.6	2.0	1.4	.6
13	1.0	6.0	.9	2.6	1.0	(a)	1.0	.6	.6	2.6	1.4	.5
14	.6	3.1	.8	2.2	1.0	(a)	3.0	.6	.6	2.3	1.4	.4
15	.6	2.0	.8	2.0	.9	(a)	1.8	.6	3.6	2.0	1.2	.4
16	.4	1.5	.9	1.8	.9	(a)	1.2	.8	5.0	1.5	1.2	.4
17	.4	1.5	.9	1.8	.9	(a)	1.2	1.7	3.1	1.4	1.2	.4
18	.4	1.0	.9	2.3	.9	(a)	1.2	2.3	2.3	1.3	1.2	.3
19	1.0	1.0	.9	3.6	1.2	(a)	1.0	2.3	1.6	1.0	1.4	.3
20	1.0	1.0	5.2	2.0	1.1	(a)	1.0	2.0	1.4	1.0	2.1	2.3
21	.4	1.0	3.6	5.0	1.0	(a)	1.0	1.0	.8	1.0	4.6	2.1
22	.4	1.0	1.8	3.0	1.0	(a)	1.0	1.0	.7	1.0	3.7	1.3
23	.4	1.0	1.8	2.0	1.0	(a)	1.0	1.0	.6	2.6	3.0	1.0
24	.4	1.0	2.8	4.0	1.8	(a)	1.0	3.0	.6	7.2	2.1	1.0
25	.4	1.0	2.1	2.0	1.4	(a)	1.0	2.0	.6	3.5	2.0	1.0
26	.4	1.0	3.6	1.8	1.2	(a)	1.0	1.0	.6	2.7	4.0	.8
27	.4	.8	2.0	1.6	1.2	(a)	1.5	.6	.6	2.5	2.2	.8
28	.4	.8	2.0	1.0	1.0	(a)	2.8	.6	.4	2.0	2.0	.7
29	.4	.....	2.0	1.0	1.0	(a)	3.5	.6	.4	1.8	1.0	.7
30	.4	.....	1.9	1.4	1.0	(a)	4.0	.6	.3	1.4	.7	.7
31	.6	.....	1.9	.....	1.0	.....	2.0	.6	.....	1.3	.....	2.3

a No record.

COOSAWATTEE RIVER AT CARTERS, GEORGIA.

This station was established August 15, 1896, at the iron highway bridge at Carters, Murray County, Georgia, about 20 miles northeast of Calhoun. The gage was last verified November 17, 1900. The station is described in Water-Supply Paper No. 36, page 144. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 146. During 1900 the following measurements were made by O. P. Hall and Max Hall:

April 28: Gage height, 2.60 feet; discharge, 1,075 second-feet.
May 11: Gage height, 2.15 feet; discharge, 811 second-feet.
May 24: Gage height, 2.05 feet; discharge, 781 second-feet.
August 13: Gage height, 1.58 feet; discharge, 576 second-feet.
September 7: Gage height, 1.25 feet; discharge, 423 second-feet.
November 17: Gage height, 1.37 feet; discharge, 458 second-feet.
November 26: Gage height, 4.08 feet; discharge, 1,899 second-feet.
December 22: Gage height, 2.70 feet; discharge, 1,132 second-feet.

Daily gage height, in feet, of Coosawattee River at Carters, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Nov.	Dec.
1	1.20	1.40	3.00	2.40	2.70	1.90	3.50	2.00	(a)	1.40
2	1.20	1.40	3.10	2.40	2.60	2.00	3.50	2.00	(a)	1.40
3	1.10	1.30	2.70	2.50	2.50	2.00	5.00	1.90	(a)	1.50
4	1.10	1.40	2.80	2.60	2.40	2.00	4.80	1.90	1.50	1.60
5	1.00	1.50	4.75	2.50	2.30	2.10	4.00	1.80	1.40	1.80
6	1.00	1.70	4.75	2.60	2.20	2.20	3.80	1.70	1.50	1.70
7	1.10	1.80	4.90	2.60	2.20	5.00	3.60	1.70	1.50	1.60
8	1.10	2.00	5.20	2.50	2.10	3.00	3.50	1.70	1.60	1.60
9	1.20	4.10	5.00	2.60	2.40	5.00	3.40	1.60	1.60	1.60
10	4.00	2.50	4.60	2.70	2.20	4.50	3.50	1.60	1.50	1.50
11	4.30	2.50	3.10	4.00	2.00	3.00	3.40	1.60	1.50	1.40
12	7.00	8.50	2.90	5.00	1.90	2.20	3.30	1.60	1.40	1.40
13	3.50	20.50	3.00	3.00	1.70	2.00	3.00	1.50	1.40	1.50
14	2.00	5.40	2.90	2.50	1.70	2.40	2.80	1.50	1.30	1.60
15	1.90	4.00	2.80	2.60	1.80	2.60	2.60	1.40	1.30	1.70
16	1.70	3.20	2.50	2.70	1.80	3.00	2.00	1.40	1.30	1.60
17	1.70	2.80	2.50	2.80	2.10	3.00	2.40	1.50	1.40	1.80
18	2.00	2.70	3.00	3.00	2.00	3.40	2.20	1.50	1.40	2.00
19	4.30	2.50	7.50	3.50	1.90	5.00	2.00	1.50	1.40	4.00
20	4.00	2.20	4.00	3.70	1.80	5.60	2.00	1.60	1.30	4.20
21	2.50	3.00	3.50	4.50	1.70	4.20	2.00	1.60	1.30	3.20
22	2.20	3.20	3.00	3.50	1.70	4.70	1.90	1.80	1.40	2.60
23	2.00	3.10	2.90	3.00	1.80	4.50	1.80	2.00	1.40	2.70
24	2.00	3.05	2.50	2.90	1.90	4.00	3.00	2.50	1.60	2.60
25	1.90	3.00	2.00	2.80	2.00	5.00	2.20	1.90	3.50	2.50
26	1.80	3.00	5.00	2.70	2.10	6.00	3.50	(a)	5.00	2.50
27	1.80	2.90	3.60	2.80	2.00	6.50	5.20	(a)	4.00	2.40
28	1.70	2.50	3.50	3.00	1.90	5.00	3.20	(a)	2.50	2.30
29	1.60	.....	3.10	3.10	1.80	4.50	2.40	(a)	1.50	2.40
30	1.50	.....	3.00	3.00	1.80	4.00	2.30	(a)	1.50	2.50
31	1.50	.....	2.80	.....	1.90	.....	2.20	(a)	.....	2.60

a No record August 26 to November 3.

OOSTANAULA RIVER AT RESACA, GEORGIA.

This station was established July 27, 1896, on the iron bridge of the Western and Atlantic Railroad in the town of Resaca, Georgia, 1,000 feet from the railroad station. It is described in Water-Supply Paper No. 36, page 146. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 147. During 1900 the following measurements were made by O. P. Hall:

April 30: Gage height, 8 feet; discharge, 5,118 second-feet.
May 15: Gage height, 3.60 feet; discharge, 1,466 second-feet.
May 25: Gage height, 3.75 feet; discharge, 1,539 second-feet.
December 11: Gage height, 4.30 feet; discharge, 1,919 second-feet.

Daily gage height, in feet, of Oostanaula River at Resaca, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Nov.	Dec.
1	2.7	3.1	6.0	5.8	6.8	3.3	2.8	4.5
2	(a)	3.0	7.3	5.4	5.7	3.5	2.9	4.2
3	(a)	3.0	6.8	5.3	5.5	4.0	3.0	4.0
4	(a)	3.1	5.9	5.6	5.3	5.5	4.6	6.0
5	(a)	4.3	5.4	6.3	4.8	5.0	4.5	8.6
6	(a)	4.2	5.1	6.0	4.6	7.7	3.7	8.3
7	2.7	3.7	6.9	5.2	4.4	7.9	3.5	6.0
8	2.6	3.5	11.3	5.0	4.0	13.0	3.0	5.6
9	2.4	5.6	15.5	4.8	3.9	10.8	2.9	5.0
10	2.5	9.1	14.2	4.6	3.8	7.5	2.8	4.8
11	4.2	7.3	11.1	7.2	3.7	5.6	2.8	4.2
12	11.3	7.8	7.6	11.6	3.6	5.8	2.8	4.0
13	11.3	20.3	6.7	9.8	3.6	6.8	2.7	4.0
14	9.9	23.0	6.0	7.4	3.4	6.6	2.7	4.0
15	6.1	23.5	5.6	6.2	3.4	5.6	2.7	4.0
16	4.9	20.8	7.3	5.8	3.4	4.8	2.7	3.9
17	4.3	13.7	6.9	6.8	3.3	6.6	2.6	3.5
18	4.1	6.5	5.9	11.9	3.3	6.8	2.6	3.4
19	6.1	5.5	6.0	12.0	3.8	10.9	2.6	3.4
20	13.1	5.2	16.9	10.4	3.9	7.0	2.7	3.8
21	12.1	5.3	17.2	11.8	3.8	6.5	2.8	10.9
22	10.2	9.1	13.8	11.6	3.7	4.8	3.6	9.3
23	6.0	8.9	8.8	9.7	3.6	9.9	3.4	6.8
24	5.2	7.3	7.7	7.7	3.7	12.8	3.3	9.0
25	4.8	7.0	8.0	7.2	3.8	14.0	3.7	8.7
26	4.4	6.7	12.2	6.2	4.0	15.0	14.4	6.7
27	4.0	6.0	10.8	5.8	4.0	17.2	13.0	5.6
28	3.7	5.5	8.3	5.6	3.7	17.5	12.2	4.6
29	3.6	.....	7.2	5.5	3.6	13.0	7.6	5.4
30	3.5	.....	6.6	7.8	3.6	9.6	5.2	5.2
31	3.4	.....	6.2	.....	3.4	.....	.....	7.7

a Frozen.

NOTE.—This is a half-year Weather Bureau station.

COOSA RIVER AT ROME, GEORGIA.

This station is described in Water-Supply Paper No. 36, page 148. Measurements of flow are made at Rome, also at Riverside, 120 miles farther downstream. The measurements at Rome are made on the Oostanaula and the Etowah just above their junction to form the Coosa. Etowah River is measured at the Second avenue bridge, and Oostanaula River at the Fifth avenue bridge, and the results added together give the flow of Coosa River at Rome. Results of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 149. During 1900 the following measurements were made by Max Hall and others:

February 21: Gage height, 4.80 feet; discharge, 8,115 second-feet.
May 19: Gage height, 2.30 feet; discharge, 4,496 second-feet.
September 13: Gage height, 0.90 foot; discharge, 1,992 second-feet.
December 8: Gage height, 3.73 feet; discharge, 6,066 second-feet.

Daily gage height, in feet, of Coosa River at Rome, Georgia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.0	4.2	4.4	6.2	2.4	10.5	3.4	1.5	1.2	2.1	3.2
2	1.6	1.8	5.8	4.2	4.8	2.5	8.0	3.2	1.5	1.2	2.2	2.8
3	1.5	1.6	5.6	4.0	4.0	2.8	8.0	3.0	1.7	1.0	2.0	2.6
4	1.5	2.0	4.4	4.0	4.0	4.2	7.0	2.8	1.7	1.0	2.3	3.5
5	1.5	3.0	4.1	4.0	3.8	4.2	5.5	2.6	1.5	.9	2.3	7.4
6	1.5	3.8	3.8	4.0	3.7	4.2	4.2	2.5	1.5	.9	2.1	6.8
7	1.5	2.8	5.0	3.8	3.6	4.8	3.8	2.2	1.4	.9	2.1	5.2
8	1.5	2.4	8.2	3.8	3.4	13.0	3.8	2.2	1.0	3.8	2.0	3.8
9	1.5	4.0	15.0	3.6	3.0	12.6	4.0	2.0	1.0	5.9	1.9	3.6
10	1.5	6.9	13.4	3.5	3.0	8.0	4.3	2.0	.8	2.6	1.8	3.2
11	2.0	7.0	10.3	6.0	3.0	5.9	3.8	1.8	.8	2.0	1.8	2.8
12	7.0	6.4	7.5	11.0	3.0	5.0	3.4	1.8	.8	1.8	1.6	2.6
13	9.0	22.6	5.5	7.4	2.5	5.2	3.8	1.8	.8	2.5	1.5	2.6
14	7.2	27.2	4.8	5.5	2.4	5.3	3.4	1.7	.8	3.2	1.5	2.4
15	5.5	25.3	4.2	4.5	2.4	4.2	3.4	2.0	6.5	3.0	1.5	2.2
16	3.5	21.2	5.3	5.6	2.4	3.8	3.3	1.7	11.1	2.0	1.5	2.2
17	3.0	18.0	5.6	6.2	2.4	4.8	3.1	1.6	7.0	1.6	1.5	2.2
18	2.9	10.7	4.5	11.0	2.4	6.0	3.0	1.8	3.2	1.5	1.4	2.0
19	5.0	5.0	5.2	11.1	2.9	6.5	2.8	2.2	2.3	1.5	1.4	2.0
20	11.3	4.0	15.9	11.4	3.0	7.2	2.6	2.0	2.0	1.4	1.6	2.8
21	10.6	4.1	17.5	13.6	2.6	4.2	2.5	1.6	1.8	1.8	1.8	6.7
22	8.5	6.8	14.6	12.7	2.5	3.6	2.4	1.6	1.8	1.8	2.1	8.0
23	5.8	7.6	10.4	10.5	2.3	5.5	2.4	1.6	1.6	1.6	2.1	7.0
24	4.0	6.0	7.2	8.6	2.9	14.2	2.4	1.9	1.6	1.6	2.0	6.6
25	3.4	5.8	8.8	8.5	3.2	18.2	3.6	2.4	1.5	1.5	5.0	6.6
26	3.1	5.2	13.0	6.5	2.7	17.0	2.8	2.0	1.5	1.5	11.0	5.6
27	2.8	4.6	12.1	5.3	2.6	15.5	6.2	1.8	1.4	1.4	11.5	4.0
28	2.6	4.0	8.9	4.8	2.5	15.6	6.8	1.6	1.4	2.2	8.6	3.8
29	2.4	.....	5.8	4.3	2.4	14.2	6.2	1.5	1.3	2.2	7.0	3.6
30	2.1	.....	5.7	6.0	2.9	10.0	4.5	1.5	1.3	2.1	4.0	3.5
31	2.0	.....	5.3	.....	3.0	.....	4.0	1.5	.....	2.1	.....	5.6

COOSA RIVER NEAR RIVERSIDE, ALABAMA.

This station, established September 25, 1896, is at the bridge of the Southern Railway near Riverside. It is described in Water-Supply Paper No. 36, page 149. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 150. During 1900 the following measurements were made by Max Hall and others:

February 10: Gage height, 5.03 feet; discharge, 13,493 second-feet.
March 21: Gage height, 12.50 feet; discharge, 43,759 second-feet.
May 5: Gage height, 4.15 feet; discharge, 11,196 second-feet.
August 21: Gage height, 2.32 feet; discharge, 5,609 second-feet.
December 28: Gage height, 4.25 feet; discharge, 11,335 second-feet.

Daily gage height, in feet, of Coosa River near Riverside, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	2.70	6.90	6.65	5.00	2.75	11.60	4.70	1.85	1.55	2.30	5.75
2	3.00	2.65	7.55	6.25	5.30	2.80	10.10	3.90	2.00	1.55	2.25	4.35
3	2.50	2.60	6.90	6.00	5.30	2.90	8.90	3.00	2.20	1.50	2.50	3.75
4	2.40	2.50	6.25	5.60	4.75	2.60	8.20	2.75	2.10	1.50	2.50	3.40
5	2.15	2.60	5.40	5.10	4.30	2.70	7.50	2.55	2.00	1.50	2.50	3.30
6	2.05	2.80	5.00	4.90	4.20	3.45	6.45	2.40	1.80	1.45	2.40	4.35
7	1.95	2.95	4.90	4.75	4.00	3.90	5.50	2.25	1.70	1.40	2.40	6.05
8	1.95	3.00	6.00	4.40	3.65	4.20	4.70	2.15	1.60	1.50	2.35	5.40
9	2.00	3.75	8.75	4.35	3.40	7.05	5.00	2.10	1.50	2.20	2.30	4.80
10	2.00	4.25	10.00	4.30	3.30	8.30	4.30	2.00	1.45	2.35	2.30	4.00
11	2.10	5.80	10.55	6.50	3.15	8.00	4.20	2.00	1.35	3.85	2.15	3.60
12	3.50	6.50	10.05	12.40	2.95	7.70	4.10	1.90	1.30	3.60	2.10	3.15
13	6.00	13.30	8.75	12.90	2.70	6.70	5.65	2.25	1.25	3.80	2.10	2.95
14	7.40	15.30	7.50	11.70	2.70	4.30	4.65	2.00	1.20	3.80	2.00	2.80
15	7.00	15.20	5.60	9.50	2.65	4.50	3.75	1.90	3.35	3.00	1.90	2.70
16	6.40	14.50	6.00	7.20	2.65	4.70	3.60	1.85	6.00	2.90	1.80	2.65
17	5.10	14.00	6.30	12.40	2.60	5.00	3.50	2.00	7.00	2.80	1.75	2.60
18	4.00	13.25	6.00	18.10	2.60	4.90	3.35	2.00	7.50	2.65	1.70	2.55
19	4.25	12.80	6.50	17.55	2.60	6.90	3.10	2.20	6.00	2.50	1.80	2.55
20	8.00	12.10	10.00	15.65	2.60	6.90	3.00	2.10	4.35	2.40	2.00	3.00
21	9.70	9.00	12.20	13.95	2.65	6.45	2.90	2.20	3.20	2.30	2.50	3.30
22	10.00	7.80	12.85	13.15	3.20	6.10	2.70	2.00	2.50	2.20	4.00	5.20
23	9.40	6.80	12.60	12.65	2.90	7.00	2.45	2.00	2.00	2.15	3.80	7.00
24	8.75	7.20	11.80	12.20	3.00	11.35	2.50	1.95	1.90	3.00	3.20	7.30
25	7.75	6.90	10.60	10.80	3.25	12.50	2.60	1.90	1.85	5.25	3.10	6.90
26	6.00	6.50	10.30	9.15	3.10	14.10	2.50	2.20	1.80	7.50	3.00	6.35
27	4.10	5.25	10.20	7.90	3.20	14.42	2.60	2.10	1.80	5.00	4.35	5.90
28	3.60	5.00	9.85	6.50	3.00	14.60	3.70	2.00	1.65	3.80	6.40	4.90
29	3.30	.....	9.50	5.70	2.80	13.80	5.70	1.95	1.60	3.00	9.20	4.30
30	3.00	.....	8.50	5.35	2.70	12.80	5.30	1.90	1.55	2.65	8.20	4.00
31	2.70	.....	7.20	.....	2.60	.....	5.90	1.90	.....	2.50	.....	6.50

COOSA RIVER AT LOCKS NOS. 4 AND 5, ALABAMA.

Records of gage heights at these stations are kept by the United States Engineer Corps, who have kindly furnished copies to the Geological Survey. Records of gage heights at Lock No. 5 during the year 1900 are not available. The records for Lock No. 4 are given in the accompanying table. Discharge measurements are not made at either of these stations. The stations are described in Water-Supply Paper No. 36, page 150.

Daily gage height, in feet, of Coosa River at Lock No. 4, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.5	2.9	7.9	6.9	5.8	3.0	13.6	5.7	1.8	1.3	2.6	7.7
2	3.0	2.7	8.4	6.1	6.0	3.2	11.0	4.4	1.9	1.2	2.4	5.3
3	2.7	2.5	7.9	5.5	6.2	3.2	10.0	3.6	2.3	1.2	2.4	4.2
4	2.4	2.5	7.4	5.3	5.4	2.8	9.4	3.2	2.1	1.2	2.7	3.9
5	2.1	2.9	6.5	5.3	4.8	3.2	8.4	2.8	1.9	1.2	2.7	4.7
6	1.9	3.2	6.0	5.4	4.7	3.8	7.3	2.5	1.8	1.2	2.7	5.7
7	1.9	3.6	6.0	5.1	4.2	4.4	6.1	2.2	1.6	1.3	2.8	7.0
8	2.0	3.9	7.8	4.9	4.0	5.0	5.1	2.2	1.6	2.0	2.9	6.8
9	2.0	4.5	10.0	4.6	3.7	7.0	5.4	2.1	1.8	2.4	2.5	5.7
10	1.9	5.9	11.2	4.9	3.7	9.0	4.7	2.0	1.2	3.9	2.3	4.8
11	2.1	6.7	11.9	7.4	3.5	9.1	4.9	2.0	1.2	4.7	2.0	4.2
12	5.8	7.5	11.6	13.9	3.4	8.0	4.4	1.9	1.1	4.2	1.9	3.8
13	7.0	15.0	10.3	14.5	3.3	6.0	4.8	2.2	1.1	4.4	1.8	3.5
14	8.6	17.5	8.6	13.0	3.1	5.0	3.3	2.0	1.2	4.4	1.7	3.3
15	7.6	17.4	6.8	10.8	3.0	5.0	3.3	1.9	4.3	3.7	1.7	3.2
16	7.6	17.0	6.8	9.0	2.9	5.3	3.7	1.8	6.4	3.3	1.7	3.0
17	6.2	16.5	7.2	14.6	2.8	5.7	3.7	2.1	8.6	3.2	1.6	2.9
18	5.1	16.1	7.0	20.3	2.8	5.5	3.5	1.9	8.7	2.7	1.6	2.8
19	4.6	15.5	7.1	20.3	2.8	7.6	3.1	2.0	6.4	2.1	1.5	2.6
20	7.9	13.7	11.2	18.0	2.9	7.9	2.9	2.2	4.4	1.9	2.1	2.8
21	10.5	10.3	13.8	16.0	3.1	7.3	2.9	2.4	3.0	1.7	2.3	3.5
22	11.5	8.6	14.7	15.0	3.2	6.7	2.7	2.3	2.4	1.6	4.5	5.5
23	11.0	8.3	14.3	14.4	3.0	6.7	2.7	2.0	2.1	2.3	4.4	7.4
24	8.9	8.4	13.5	13.8	3.4	12.1	2.7	1.8	1.9	3.5	4.0	8.5
25	7.0	8.3	12.0	12.2	3.6	14.2	2.8	1.9	1.8	5.0	3.6	8.1
26	5.5	7.5	11.6	10.2	3.3	16.6	2.7	2.3	1.7	8.6	6.1	8.5
27	4.5	6.8	11.6	9.2	3.5	15.5	4.0	2.4	1.7	8.2	9.0	6.9
28	4.0	6.2	11.8	7.8	3.0	17.0	4.2	2.3	1.6	5.2	10.2	6.0
29	3.8	.....	11.0	6.8	3.0	15.2	5.6	1.9	1.5	4.5	10.0	5.1
30	3.3	.....	9.9	6.0	2.8	14.5	6.3	2.0	1.5	2.9	8.7	4.5
31	3.0	.....	8.0	.....	2.8	.....	6.8	1.9	.....	2.6	.....	6.0

TALLAPOOSA RIVER NEAR SUSANNA, ALABAMA.

This station was established July 27, 1900, by J. R. Hall. It is located at the mouth of Blue Creek, which is 10 feet above the east landing of McCarty's ferry, 13 miles southwest of Dadeville, and 3 miles from Susanna, the nearest post-office. The rod is graduated to feet and tenths; it is 18 feet long, and is nailed vertically to a tree overhanging the water on the south side of the creek at the junction of the creek and the river. The gage is referred to a bench mark on a white hickory tree about 40 feet from the rod on the south bank of the creek, and is 376.67 feet above tide water. Discharge measurements are made from a boat held in place by a wire stretched across the river, upon which the distances from the initial point are tagged. The section is an exceptionally good one, depth and current being almost uniform the entire width of the stream. The observer is T. A. Walls, a farmer who lives 1 mile from the station. During 1900 the following measurements were made by James R. Hall:

July 27: Gage height, 1.80 feet; discharge, 2,309 second-feet.
August 9: Gage height, 1.55 feet; discharge, 1,900 second-feet.
September 28: Gage height, 1.50 feet; discharge, 1,809 second-feet.
November 24: Gage height, 2.40 feet; discharge, 3,629 second-feet.

Daily gage height, in feet, of Tallapoosa River near Susanna, Alabama, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.80	2.40	1.40	1.80	2.00	17	.....	1.95	8.40	2.35	1.75	2.60
2	.....	4.00	3.80	1.40	1.70	2.00	18	.....	1.95	4.80	2.30	1.75	2.50
3	.....	2.00	4.80	1.40	1.70	2.10	19	.....	1.80	3.00	2.20	1.80	2.40
4	.....	1.80	4.20	1.35	1.65	2.20	20	.....	1.75	2.50	2.10	1.85	4.50
5	.....	1.80	2.25	1.30	1.65	2.30	21	.....	1.70	1.80	1.90	1.85	5.80
6	.....	2.10	1.50	2.80	1.65	2.50	22	.....	1.70	1.80	1.70	1.90	4.50
7	.....	2.20	1.45	3.00	1.60	2.40	23	.....	1.90	1.80	3.90	2.40	4.00
8	.....	1.70	1.45	2.50	1.60	2.40	24	.....	2.00	1.70	6.00	2.40	4.00
9	.....	1.55	1.40	1.85	1.60	2.40	25	.....	2.05	1.60	5.00	3.00	3.70
10	.....	1.50	1.35	1.80	1.60	2.30	26	.....	2.50	1.50	4.30	4.90	3.20
11	.....	1.40	1.35	1.75	1.60	2.10	27	1.80	2.15	1.50	4.10	4.20	2.80
12	.....	1.40	1.35	1.70	1.55	2.00	28	1.90	2.00	1.50	2.30	3.90	2.70
13	.....	1.40	1.35	1.90	1.55	1.90	29	1.80	1.90	1.45	2.20	3.00	2.60
14	.....	1.40	1.30	2.40	1.60	3.80	30	4.00	1.80	1.45	1.90	2.80	2.70
15	.....	1.40	1.35	2.45	1.60	3.90	31	6.80	2.25	.....	1.85	.....	2.90
16	.....	1.90	11.70	2.40	1.60	2.80							

TALLAPOOSA RIVER NEAR STURDEVANT, ALABAMA.

This station was established July 19, 1900, by J. R. Hall. It is located at the Columbus and Western Railroad bridge a fourth of a mile west of Sturdevant. The gage rod is 20 feet high, and is graduated to feet and tenths. It is in two sections and is fastened vertically, the shorter section to a post at the edge of the water on the east bank about 20 feet below the bridge, and the longer section to the first stone pier from the east bank. It is so set that when the water rises above the short section it is on the long section, and the readings are made as from one continuous rod. The initial point of sounding is the east end of the bridge. The section is broken by three piers and by some large rocks below the bridge. The gage is referred to a bench mark consisting of a nail in the southwest corner of pier No. 2, east side of river, 455.70 feet above tide water and 14.20 feet above the zero of the gage. The observer is B. F. Neighbors, farmer and postmaster at Sturdevant, who lives a fourth of a mile from the station. During 1900 the following measurements were made by James R. Hall:

July 20: Gage height, 2.85 feet; discharge, 2,603 second-feet.
August 13: Gage height, 1.95 feet; discharge, 1,887 second-feet.

Daily gage height, in feet, of Tallapoosa River near Sturdevant, Alabama, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.30	3.40	1.80	2.50	2.90	17	.....	3.00	7.90	2.60	2.30	3.20
2	.....	3.40	6.10	1.70	3.40	2.80	18	.....	2.80	5.00	2.20	2.20	3.10
3	.....	2.80	4.20	1.60	4.70	2.70	19	2.95	4.00	3.80	2.10	2.20	3.00
4	.....	2.50	2.90	1.60	3.60	3.00	20	2.80	2.90	3.00	2.00	2.20	5.20
5	.....	2.40	2.50	3.30	3.30	3.20	21	3.05	2.40	2.70	1.90	2.50	6.80
6	.....	2.35	2.20	3.00	3.20	3.30	22	2.75	2.30	2.50	2.10	3.20	5.30
7	.....	2.25	2.00	3.00	2.90	3.20	23	2.65	2.40	2.40	5.00	3.50	4.90
8	.....	2.20	1.90	2.90	2.70	3.00	24	2.55	2.70	2.30	7.30	3.20	5.60
9	.....	2.10	1.80	3.10	2.60	2.80	25	2.65	2.50	2.20	6.40	4.80	4.70
10	.....	2.00	1.70	3.20	2.50	2.70	26	2.60	2.80	2.10	5.40	5.90	4.20
11	.....	1.95	1.60	3.30	2.40	2.60	27	2.50	2.60	2.00	4.20	5.40	3.90
12	.....	1.90	1.60	3.40	2.40	2.60	28	2.70	2.50	2.00	3.60	3.40	3.60
13	.....	2.00	1.60	3.50	2.40	2.70	29	6.50	2.40	2.00	2.90	3.20	3.40
14	.....	2.10	1.80	3.50	2.30	4.70	30	7.60	2.30	1.90	2.70	3.10	3.50
15	.....	2.60	8.80	3.00	2.30	3.00	31	5.00	2.80	.....	2.60	.....	7.50
16	.....	3.40	12.00	2.60	2.30	3.70							

TALLAPOOSA RIVER NEAR MILSTEAD, ALABAMA.

This station was established August 7, 1897, at the bridge of the Tallassee and Montgomery Railway, about a fourth of a mile from Milstead. It is described in Water-Supply Paper No. 36, page 152. The gage was last verified December 3, 1900. Records of discharge measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 151. During 1900 the following measurements were made by Max Hall:

February 23: Gage height, 9.20 feet: discharge, 9,956 second-feet.
March 5: Gage height, 6.70 feet: discharge, 7,088 second-feet.
December 3: Gage height, 2.95 feet; discharge, 3,031 second-feet.

Daily gage height, in feet, of Tallapoosa River near Milstead, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.50	13.20	5.50	6.30	2.60	9.00	6.50	2.70	1.80	2.50	3.30
2	2.60	2.40	13.10	5.30	5.90	2.70	9.10	4.50	8.00	1.60	3.30	3.30
3	2.40	2.30	10.70	5.00	5.40	3.00	10.60	3.50	8.10	1.50	6.10	3.30
4	2.30	4.50	8.00	5.30	4.90	3.50	7.10	2.80	4.40	1.80	6.50	3.50
5	2.30	4.20	6.80	4.80	4.70	3.30	8.00	2.70	3.00	3.30	7.10	3.90
6	2.30	4.30	6.10	4.70	3.90	3.50	5.20	2.50	2.40	6.40	5.50	3.90
7	2.20	4.40	5.60	4.60	3.80	3.30	4.40	2.30	2.20	3.40	4.10	3.80
8	2.20	3.80	10.90	4.60	3.70	5.90	4.00	2.20	2.00	3.20	3.50	3.80
9	2.20	5.20	13.80	4.50	3.60	9.70	3.50	2.10	1.80	2.60	3.00	3.10
10	2.20	8.90	12.70	4.60	3.50	6.90	7.60	2.00	1.70	2.60	2.90	3.10
11	2.60	19.00	10.00	5.50	3.30	5.60	5.50	1.90	1.70	3.00	2.70	2.80
12	7.30	30.00	7.90	10.60	3.20	4.60	4.10	1.90	1.60	2.80	2.60	2.80
13	6.00	43.25	6.60	11.50	3.10	5.30	4.70	1.80	1.50	3.40	2.60	2.80
14	4.50	42.00	5.90	9.00	3.00	4.00	6.70	1.90	1.50	3.30	2.50	7.70
15	4.00	31.90	5.40	6.60	2.90	3.80	6.00	2.20	14.00	3.30	2.50	9.10
16	3.40	22.80	7.00	5.30	2.90	3.50	5.10	2.70	25.60	2.70	2.50	7.30
17	3.00	13.50	7.20	4.70	2.80	4.50	3.80	3.10	18.00	2.70	2.50	5.20
18	2.90	8.30	5.60	13.90	2.80	5.90	3.80	2.50	11.00	2.20	2.50	4.20
19	3.70	7.00	5.40	17.00	2.80	5.00	3.60	4.00	5.30	2.10	2.50	4.00
20	9.50	6.10	6.00	15.00	2.90	5.90	3.10	4.20	3.60	2.00	2.50	8.00
21	7.50	6.50	11.40	16.90	2.80	5.90	3.00	2.50	3.00	1.90	2.50	17.00
22	5.90	9.80	10.50	13.30	3.00	5.50	2.80	2.20	2.50	2.00	4.00	13.50
23	4.60	9.50	7.60	10.30	3.10	5.40	2.70	2.00	2.30	4.80	4.00	10.40
24	3.90	8.90	15.50	13.20	3.40	20.00	2.60	2.30	2.20	12.10	3.90	11.30
25	3.50	8.40	15.20	12.50	3.50	25.04	2.50	3.30	2.00	10.50	3.50	8.70
26	3.10	8.00	16.00	9.40	5.00	20.00	2.50	3.40	2.00	9.00	10.50	6.60
27	3.00	7.00	13.70	7.50	4.50	16.00	2.80	3.60	2.00	6.00	8.80	5.60
28	2.80	6.00	11.20	6.40	3.20	18.00	2.90	2.70	2.00	4.20	6.70	5.00
29	2.70	.....	8.70	6.20	2.70	13.80	3.20	2.60	2.00	2.20	4.50	4.60
30	2.60	.....	7.10	6.10	3.00	9.00	8.10	2.10	1.90	2.90	3.70	4.30
31	2.50	.....	6.20	.....	2.50	.....	10.60	3.20	.....	2.70	.....	11.60

ALABAMA RIVER AT MONTGOMERY, ALABAMA.

This station was established by the United States Engineer Corps a number of years ago, at the Montgomery wharf, near the union passenger station at the foot of Commerce street. The readings are now taken by the Weather Bureau, and copies are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 36, page 153. No measurements were made in 1899 or previous years. During 1900 one measurement was made by Max Hall, as follows:

March 6: Gage height, 11.40 feet; discharge, 29,470 second-feet.

Daily gage height, in feet, of Alabama River at Montgomery, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.9	6.0	12.4	14.0	10.2	3.5	29.0	10.6	3.0	1.7	3.7	10.6
2	4.3	5.8	17.6	10.8	9.6	3.5	24.8	9.9	3.5	1.6	3.7	9.2
3	3.9	5.3	19.0	9.2	9.2	3.9	22.5	6.6	5.7	1.4	4.2	7.0
4	3.5	5.0	19.4	8.6	9.2	4.5	20.2	5.3	5.0	1.4	12.6	6.2
5	3.2	6.0	14.6	8.1	8.3	4.4	17.2	4.5	4.4	1.5	10.6	5.8
6	2.9	6.1	11.8	7.3	7.2	4.4	14.8	3.9	2.9	3.0	8.2	5.6
7	2.5	6.1	10.1	7.3	6.6	4.4	12.2	3.3	2.5	4.1	5.7	6.7
8	2.2	6.1	10.1	7.3	6.2	5.0	9.8	3.2	2.0	3.9	4.9	7.6
9	2.2	6.1	15.3	7.3	5.6	10.0	7.4	3.0	1.8	5.1	4.5	7.8
10	2.2	8.0	18.6	7.3	5.6	11.0	6.4	2.6	1.6	3.7	4.0	7.0
11	2.8	14.2	19.6	7.3	5.3	12.0	8.4	2.6	1.6	3.4	3.5	6.0
12	8.0	21.2	19.5	13.5	5.0	12.0	7.6	2.5	1.4	4.0	3.2	5.1
13	10.6	31.2	18.4	20.5	5.0	10.5	7.6	2.4	1.0	8.5	3.0	4.5
14	10.6	43.8	16.5	23.5	4.8	9.5	8.0	2.2	1.2	8.0	3.0	6.0
15	11.0	48.4	13.7	24.0	4.6	7.0	9.9	2.2	7.0	6.0	2.7	9.0
16	11.0	47.8	11.7	18.8	4.4	6.2	10.0	2.5	16.0	5.2	2.7	8.2
17	9.6	44.5	11.9	16.8	4.0	6.9	6.4	2.5	17.2	4.1	2.5	7.1
18	8.0	41.2	11.3	23.5	4.0	8.1	5.2	2.7	16.7	3.7	2.5	6.2
19	8.0	37.5	10.6	29.0	4.0	8.1	5.0	3.1	15.8	3.4	2.3	5.0
20	10.0	33.5	13.3	34.5	4.0	9.0	4.8	3.1	10.2	2.6	2.2	4.8
21	12.4	35.5	19.3	36.4	4.0	9.7	4.5	3.0	8.0	2.0	1.7	10.0
22	14.6	28.0	22.5	36.5	3.8	10.2	4.0	2.6	4.7	1.9	6.0	12.8
23	16.0	23.6	23.5	33.5	3.8	10.2	4.0	2.7	3.5	5.5	7.0	14.0
24	15.4	21.0	25.1	31.2	4.6	14.2	3.8	3.0	3.0	8.0	6.6	14.5
25	12.9	18.6	26.8	29.3	4.9	22.0	3.6	3.0	2.6	9.4	6.6	14.0
26	11.6	14.2	28.1	26.5	5.2	27.4	3.6	3.0	2.4	8.2	9.9	13.4
27	7.4	12.8	27.8	22.2	5.0	29.5	3.6	3.0	2.3	9.8	13.0	10.6
28	7.0	11.6	25.6	17.8	4.7	30.8	5.2	3.3	2.0	10.6	13.4	9.8
29	6.8	.....	23.2	14.6	4.5	32.8	7.0	3.3	2.0	8.6	13.4	8.8
30	6.4	.....	20.5	11.2	4.3	31.8	9.2	3.0	1.7	5.5	11.5	9.0
31	6.3	.....	17.5	.....	3.8	.....	11.6	2.9	.....	4.3	.....	10.0

ALABAMA RIVER AT SELMA, ALABAMA.

This station was originally established by the United States Engineer Corps; readings are now taken by the United States Weather Bureau. The gage, which is attached to the iron highway bridge, the floor of which is about 60 feet above low water, is in two sections. The lower section, which reads from −3.0 feet to +2.30 feet, is secured to the pile on the lower side of the cofferdam on the draw pier; the upper section, which reads from 2.30 feet to 48 feet, is spiked to the highway bridge. The bench mark, which is an iron bolt driven into the face of a rock bluff 182.3 feet from the first bridge pier, on the road ascending to the city, is 26 feet above the zero of the gage and 87.30 feet above mean sea level. The top of the coping stone of the pivot pier at the highway bridge to which gage is attached is 56 feet above the zero of the gage and 117.30 feet above mean sea level. Graduations extend from −3.0 feet to +48 feet. During 1900 the following measurements were made:

April 14: Gage height, 23.60 feet; discharge, 66,607 second-feet.
May 26: Gage height, 6.10 feet; discharge, 17,049 second-feet.
August 24: Gage height, 3.10 feet; discharge, 9,879 second-feet.

Daily gage height, in feet, of Alabama River at Selma, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.2	4.8	17.2	19.8	15.4	4.8	34.8	14.0	3.9	0.8	2.0	16.0
2	6.6	3.6	19.7	16.8	13.9	4.6	33.0	13.0	3.9	.7	2.0	14.0
3	4.3	3.5	22.2	14.0	13.0	4.4	29.8	11.0	3.8	.6	4.0	11.0
4	3.3	3.9	22.0	12.0	12.0	4.2	26.5	9.0	4.5	.6	9.0	9.0
5	3.0	4.7	20.6	10.9	11.8	5.6	23.5	7.0	5.4	.5	14.0	8.0
6	3.0	6.2	17.8	8.0	10.2	5.0	20.2	6.0	5.0	1.0	13.5	7.5
7	3.0	8.2	15.0	7.8	9.6	4.6	17.0	5.5	4.5	1.8	9.4	7.0
8	3.0	8.4	13.9	8.9	8.8	4.2	14.0	5.0	4.1	2.5	6.3	7.0
9	2.7	8.5	14.9	9.6	8.0	6.8	11.5	4.8	3.3	4.0	4.0	9.0
10	2.7	10.7	18.8	9.5	7.8	11.6	10.0	4.5	1.8	4.2	2.0	9.4
11	3.3	16.0	20.9	9.8	7.5	13.5	9.8	3.2	1.0	2.0	2.0	6.0
12	7.7	22.2	22.2	12.0	7.3	14.0	10.2	3.0	.7	2.0	1.9	5.0
13	12.4	29.9	22.0	17.7	7.0	13.9	10.0	2.8	.6	2.5	1.6	2.0
14	13.5	38.6	19.9	23.4	6.6	12.8	9.9	2.5	1.0	4.3	1.6	3.2
15	14.7	44.0	19.0	25.5	6.4	11.0	9.9	2.5	1.6	6.7	1.0	9.0
16	14.0	47.0	16.9	25.0	6.0	9.0	10.0	2.4	11.0	6.0	1.0	11.0
17	13.2	48.0	15.3	22.5	5.7	8.9	9.9	2.8	18.0	5.2	1.0	11.0
18	12.0	47.9	13.9	23.5	5.5	8.8	9.0	2.7	19.0	2.5	1.0	10.0
19	11.1	47.0	14.3	29.0	5.2	8.6	7.0	2.7	19.4	1.0	1.0	6.0
20	11.1	44.1	14.6	34.8	5.1	10.0	7.0	2.5	16.0	1.0	1.0	5.1
21	13.4	41.6	18.8	39.0	5.0	10.9	6.5	2.3	12.5	.9	1.0	9.0
22	16.9	36.9	23.0	39.8	5.0	12.0	6.5	2.6	10.0	1.0	1.6	14.5
23	18.5	33.2	25.5	41.0	4.8	12.9	6.3	3.6	6.0	1.5	6.0	17.0
24	18.3	22.6	29.0	40.0	5.5	14.0	6.0	3.8	3.0	6.0	9.0	17.2
25	17.0	22.6	30.2	38.5	6.1	17.6	5.8	4.0	1.9	11.5	9.8	17.6
26	14.7	21.1	32.7	35.8	6.2	24.5	5.0	3.5	1.6	12.0	9.9	18.0
27	13.0	19.0	33.3	32.7	6.6	29.0	4.5	3.5	1.0	11.5	13.0	17.0
28	11.2	16.9	32.5	28.5	6.8	32.0	4.4	3.4	1.0	12.3	16.0	14.5
29	8.4	.....	30.5	23.0	6.0	33.5	7.5	3.5	.9	13.0	16.8	12.9
30	6.5	.....	27.7	18.0	5.5	35.0	8.0	4.0	.8	11.0	17.0	11.2
31	4.8	.....	24.4	.....	5.0	.....	11.8	4.2	.....	5.0	.....	11.0

BLACK WARRIOR RIVER AT TUSCALOOSA, ALABAMA.

A continuous record of the gage heights at Tuscaloosa has been kept by the United States Engineer Corps since 1889. During 1895 and 1896 a number of discharge measurements were made, from which a rating table was established. Since that time measurements of flow and computations of the discharge have been made regularly by the United States Geological Survey. The station is described in Water-Supply Paper No. 36, page 156. The records are furnished by R. C. McCalla, jr., United States assistant engineer. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 153. No measurements were made during the year 1900.

Daily gage height, in feet, of Black Warrior River at Tuscaloosa, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.90	6.92	18.14	21.55	21.23	4.24	41.00	9.85	5.50	0.75	4.20	12.50
2	9.48	6.40	25.44	18.60	18.95	5.30	33.88	8.00	5.00	.80	5.10	9.65
3	8.32	5.00	26.00	15.80	16.33	13.95	32.27	6.50	4.07	.60	5.40	8.50
4	7.10	5.17	23.30	13.60	13.82	15.16	32.13	5.15	4.30	.25	5.55	7.90
5	6.18	6.40	20.29	12.27	11.60	20.98	30.96	4.40	3.58	.40	5.05	8.20
6	5.53	9.58	17.43	12.17	9.60	21.50	27.31	3.80	2.80	.40	4.45	10.20
7	5.12	11.50	15.34	11.44	8.20	20.92	23.70	3.35	2.30	.80	3.90	10.65
8	4.84	16.53	27.58	10.29	7.28	21.75	20.80	3.00	1.90	1.80	3.50	9.65
9	4.60	12.23	39.00	9.97	6.80	38.25	18.45	2.50	1.50	3.90	3.10	8.75
10	4.50	20.60	36.03	10.58	6.50	31.70	15.96	2.30	1.40	6.05	2.90	8.15
11	7.12	23.00	31.63	26.35	6.12	24.73	12.96	2.10	1.10	6.10	2.70	7.50
12	31.63	20.64	27.34	52.79	5.90	19.60	11.05	2.00	.90	14.30	2.50	6.90
13	31.80	41.37	23.78	53.40	5.48	15.95	10.60	1.75	.80	22.50	2.40	6.45
14	28.18	47.96	20.43	48.69	4.96	15.60	12.90	1.50	1.40	21.85	2.25	6.40
15	24.09	45.73	17.40	42.30	4.50	19.23	10.35	1.40	5.45	16.40	2.20	6.65
16	20.12	40.23	16.63	37.10	3.85	29.15	8.50	1.50	10.65	11.60	2.10	6.45
17	16.50	34.74	21.18	63.00	3.65	28.89	7.00	1.48	8.95	8.20	2.05	6.10
18	14.28	29.75	20.28	64.05	3.50	25.33	6.00	1.40	6.34	6.13	2.00	5.75
19	15.80	26.88	18.80	62.17	3.52	24.51	5.60	3.00	4.44	5.10	1.95	5.30
20	25.00	22.43	45.10	59.35	3.39	30.10	6.35	4.40	3.35	4.30	3.90	5.45
21	32.60	19.90	51.00	56.10	3.65	27.80	8.50	3.75	2.60	3.60	8.40	6.30
22	29.44	23.58	47.98	51.71	3.50	25.38	8.00	3.00	2.20	3.15	10.25	8.35
23	24.54	26.50	42.40	46.20	3.35	24.55	8.10	2.50	1.87	4.60	12.50	11.90
24	20.43	24.20	38.24	41.88	4.40	50.00	8.70	2.55	1.65	7.30	11.00	17.00
25	17.12	22.38	35.41	37.94	7.55	58.35	7.40	2.10	1.60	10.40	9.45	18.70
26	14.12	21.00	36.78	33.94	7.68	56.35	6.80	4.48	1.45	8.55	15.90	17.00
27	12.14	18.63	35.33	30.89	6.70	52.90	9.20	4.30	1.30	6.75	22.20	14.60
28	10.47	16.52	31.80	28.15	5.30	49.05	16.20	3.25	1.05	5.40	21.00	12.50
29	9.10	.....	28.85	25.73	4.25	48.25	13.50	2.40	.90	4.70	17.35	10.95
30	8.27	.....	26.25	23.50	3.60	46.35	11.83	2.10	.75	4.10	14.00	10.15
31	7.60	.....	24.20	.....	3.62	.....	11.05	2.50	.....	3.70	.....	14.20

BLACK WARRIOR RIVER NEAR CORDOVA, ALABAMA.

This station is located at the Kansas City, Memphis and Birmingham Railroad bridge three-fourths of a mile from Cordova, Alabama. The gage was established by the United States Weather Bureau, but records were discontinued by that bureau some time ago. From 12 to 55 feet the gage is a vertical timber bolted to the inside of the bridge pier on the left bank of the river. Below 12 feet the gage was sloping, but it was out of position and could not be used when the station was established by the Geological Survey on May 21, 1900, so a short new section was put in at that time. This section is a 2-inch by 10-inch plank, graduated to feet and tenths, marked with nails from −1.5 feet to +12.5 feet, and spiked to a willow tree on the right bank of the river about 200 feet below the bridge. The bench mark is the top of the stone pier on the left bank, and is 54.95 feet above the zero of the gage. Measurements are made from the railroad bridge, which is a single-span, iron, through bridge 300 feet long. The section is a good one. The observer is A. B. Logan, who lives on the right bank of the river, only a few hundred feet from the end of the bridge. During 1900 one measurement was made by Max Hall, as follows:

May 21: Gage height, 0.10 foot; discharge, 747 second-feet.

Daily gage height, in feet, of Black Warrior River near Cordova, Alabama, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.6	8.1	0.9	0.5	—0.8	—0.1	1.4
2	.....	2.8	5.2	.5	.2	— .8	+ .5	1.0
3	.....	5.3	7.1	.4	.1	— .9	.8	.8
4	.....	7.1	6.5	.2	.0	— .9	.4	1.0
5	.....	7.5	5.3	.1	— .1	—1.0	.3	1.9
6	.....	7.6	4.6	.0	— .2	—1.0	.3	1.8
7	.....	6.5	3.5	.1	— .3	—1.1	.2	1.4
8	.....	7.3	2.1	.2	— .4	+ .2	.2	1.2
9	.....	6.5	2.5	.3	— .5	.9	.1	1.0
10	.....	4.5	2.7	.3	— .5	.9	.0	.8
11	.....	3.2	1.0	.4	— .6	.1	— .1	.7
12	.....	3.0	.8	.5	— .6	9.4	— .2	.7
13	.....	4.6	1.0	.5	— .7	9.2	— .2	.8
14	.....	8.6	.8	.5	— .6	3.2	— .3	.8
15	.....	9.8	.5	.6	1.5	2.3	— .3	.8
16	.....	8.0	.4	.6	.9	1.7	— .3	.6
17	.....	8.2	.4	.6	.5	1.0	— .4	.5
18	.....	7.2	.3	.6	.1	.6	+ .3	.4
19	.....	13.4	.3	.1	.0	.3	.2	.4
20	.....	10.0	.2	.0	— .1	.2	.1	.5
21	0.1	6.1	.7	.2	— .2	.1	.3	1.5
22	.1	6.5	1.0	.3	— .3	.0	1.1	3.0
23	.1	15.2	.8	.4	— .3	1.0	.8	2.9
24	1.5	32.9	.5	.8	— .4	.7	.8	5.0
25	1.5	31.8	.9	1.7	— .4	.5	.9	4.0
26	1.0	31.3	.5	.8	— .5	.3	5.1	3.1
27	.6	22.1	1.6	.2	— .5	.2	4.9	2.5
28	.7	23.9	2.4	.0	— .6	.1	3.6	2.1
29	.8	22.4	1.3	.1	— .7	.0	2.8	1.8
30	.9	16.5	1.2	.9	— .7	— .1	1.9	1.7
31	.9	.....	1.5	1.0	.....	— .1	.....	2.8

HILLABEE CREEK NEAR ALEXANDER CITY, ALABAMA.

This station, which was established August 29, 1900, by J. R. Hall, is located 6½ miles northeast of Alexander City, on the road leading from that town to Newsite. The gage, which is graduated to feet and tenths and is placed vertically, is in two sections, the short section, which reads from 0 to 5.50 feet, being fastened to a post in the edge of the water on the north bank 20 feet from the upstream side of the bridge, the long section, which reads from 5.50 feet to 16 feet, being fastened to the upstream end of the first pier on the north bank, and arranged so that when water rises above the short section the readings are made from the long one, both sections being easily read from the north approach to the bridge. The initial point of sounding is on the south side of the first pier on the north bank. The gage is referred to a bench mark at the top of a chord on the downstream side of the bridge at the second pier from the north bank, and is 27.6 feet above the zero of the gage. The bridge is in three spans having a total length of 276 feet, with a north approach of 116 feet and a south approach of 124 feet, making a total, over all, of 516 feet. The observer is J. H. Chisholm, a farmer, post-office address Alexander City, Alabama. During 1900 the following measurements were made by James R. Hall:

August 29: Gage height, 1.40 feet; discharge, 184 second-feet.
November 28: Gage height, 2 feet; discharge, 390 second-feet.

Daily gage height, in feet, of Hillabee Creek near Alexander City, Alabama, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.3	1.3	1.6	1.9	17	.....	2.6	1.3	1.5	2.7
2	.....	2.3	1.1	2.6	1.9	18	.....	2.2	1.3	1.4	2.8
3	.....	1.6	1.1	6.8	1.8	19	.....	1.6	1.2	1.5	3.0
4	.....	1.4	1.1	3.2	1.9	20	.....	1.5	1.2	1.6	2.9
5	.....	1.3	3.2	2.2	1.8	21	.....	1.5	1.2	1.7	6.0
6	.....	1.2	2.0	1.8	1.9	22	.....	1.4	1.9	2.1	4.0
7	.....	1.2	2.8	1.7	1.8	23	.....	1.2	5.9	1.9	3.0
8	.....	1.1	2.6	1.7	1.7	24	.....	1.3	2.9	1.9	2.9
9	.....	1.1	2.4	1.8	1.7	25	.....	1.4	2.1	5.1	2.9
10	.....	1.2	2.3	1.7	1.7	26	.....	1.3	1.9	2.9	2.8
11	.....	1.1	2.3	1.7	1.7	27	.....	1.4	1.8	2.4	2.6
12	.....	1.1	1.8	1.7	1.7	28	.....	1.3	1.7	2.0	2.5
13	.....	1.1	1.6	1.7	1.8	29	1.4	1.4	1.6	1.9	2.5
14	.....	1.1	1.4	1.7	3.8	30	1.3	1.3	1.5	1.9	5.8
15	.....	8.1	1.4	1.7	2.9	31	1.8	.....	1.5	.....	5.7
16	.....	5.0	1.2	1.6	2.8						

TALLADEGA CREEK AT NOTTINGHAM, ALABAMA.

This station is located on the Southern Railroad bridge a fourth of a mile from the depot at Nottingham, Alabama, and 1 mile north of Alpine, Alabama. The gage, which is graduated to feet and tenths and is 20 feet long, is fastened vertically to the north end of the bridge on the upstream side, the bottom end of the gage being nailed to an old mudsill projecting from the north bank. The initial point of sounding is at the gage. The bench mark is the top rail on the upstream side of the bridge, and is 24.13 feet above gage datum. The section is a good one and is free from piers. The observer is R. M. McClatchy, station agent at Nottingham. During 1900 the following measurements were made by James R. Hall:

August 16: Gage height, 1.10 feet; discharge, 102 second-feet.
November 29: Gage height, 1.70 feet; discharge, 240 second-feet.

Daily gage height, in feet, of Talladega Creek at Nottingham, Alabama, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.2	1.0	1.3	1.6	17	1.2	2.3	1.1	1.2	1.5
2	.....	2.0	1.0	1.3	1.4	18	1.2	1.7	1.1	1.2	1.5
3	.....	1.3	1.0	2.3	1.4	19	1.1	1.6	1.1	1.2	1.4
4	.....	1.1	1.0	2.1	1.8	20	1.1	1.5	1.0	1.5	2.7
5	.....	1.0	1.2	1.7	1.7	21	1.1	1.3	1.2	2.2	3.0
6	.....	1.0	1.3	1.5	1.6	22	1.1	1.2	1.4	1.9	2.6
7	.....	1.0	1.3	1.4	1.5	23	1.1	1.2	1.6	1.8	4.0
8	.....	.9	1.4	1.4	1.5	24	1.0	1.2	2.9	1.6	3.5
9	.....	11.0	1.3	1.3	1.4	25	.9	1.2	3.5	3.9	2.1
10	.....	8.0	1.3	1.3	1.3	26	1.0	1.2	3.0	3.8	2.0
11	.....	10.3	1.3	1.3	1.3	27	1.1	1.2	2.6	3.4	1.8
12	.....	8.0	1.5	1.3	1.3	28	1.2	1.2	1.4	2.0	1.7
13	.....	8.3	1.4	1.2	1.6	29	1.0	1.1	1.3	1.8	1.6
14	.....	9.3	1.3	1.2	1.8	30	1.0	1.1	1.3	1.7	1.9
15	.....	9.3	1.2	1.2	1.7	31	1.6	.....	1.3	.....	5.1
16	1.1	3.9	1.2	1.2	1.6						

BIG SANDY CREEK NEAR DADEVILLE, ALABAMA.

This station, which was established by J. R. Hall August 2, 1900, is located about 4½ miles southwest of Dadeville, at the highway bridge on the Dadeville-Susanna road. The gage, which is graduated to feet and tenths, is 16 feet high and is fastened vertically to the first pier on the north side of the creek. The initial point of sounding is at the gage rod. The section is good for ordinary or flood measurements, but is rather wide and shoaly for low-water measurements. The latter can, however, be made a short distance from the gage. The observer is L. H. Finch, a farmer who lives 200 yards from the station, post-office address, Dadeville, Alabama. During 1900 the following measurements were made by James R. Hall:

July 6: Gage height, 1.20 feet; discharge, 260 second-feet.
August 8: Gage height, 1.00 foot; discharge, 110 second-feet.
August 8: Gage height, 1.00 foot; discharge, 116 second-feet.
August 25: Gage height, 1.35 feet: discharge, 281 second-feet.
November 16: Gage height, 1.10 feet; discharge, 155 second-feet.
December 31: Gage height, 2.00 feet; discharge, 870 second-feet.

The measurements of August 8 and November 16 were made a half mile below Smith's bridge.

Daily gage height, in feet, of Big Sandy Creek near Dadeville, Alabama, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.10	0.95	1.00	1.10	17	1.80	3.90	1.10	1.05	1.45
2	1.20	1.10	.90	1.30	1.15	18	1.20	1.50	1.00	1.10	1.30
3	1.10	1.40	.90	2.00	1.25	19	1.10	1.10	1.05	1.10	2.40
4	1.10	1.30	.90	1.80	1.40	20	1.00	1.05	1.05	1.10	4.50
5	1.10	1.20	3.50	1.40	1.35	21	1.00	1.00	1.00	1.10	3.50
6	1.05	1.05	1.80	1.20	1.30	22	.90	1.00	1.50	1.30	1.70
7	1.05	1.00	1.25	1.20	1.25	23	.90	1.00	1.45	1.25	1.50
8	1.00	1.00	1.20	1.20	1.20	24	1.70	1.00	1.40	1.20	1.40
9	1.05	.95	1.10	1.15	1.15	25	1.40	1.00	1.20	1.50	1.40
10	1.00	2.00	1.15	1.15	1.10	26	1.60	1.00	1.15	1.90	1.35
11	1.00	1.80	1.10	1.15	1.10	27	1.15	1.05	1.10	1.80	1.35
12	9.05	1.40	1.20	1.15	1.10	28	1.10	1.05	1.05	1.20	1.35
13	9.00	1.20	1.30	1.10	1.10	29	1.00	1.00	1.05	1.15	1.30
14	9.00	1.20	1.15	1.10	2.20	30	1.00	.90	1.00	1.10	1.75
15	1.80	2.00	1.10	1.10	1.80	31	1.80	.....	1.05	.....	2.00
16	1.00	2.20	1.05	1.10	1.45						

TOMBIGBEE RIVER AT COLUMBUS, MISSISSIPPI.

This station is located about 1,000 feet below the highway bridge 1½ miles from the Southern Railway depot at Columbus. The rod, which is in three sections, is fastened vertically to the rock bluff on the left bank. It is a 3-inch by 10-inch pine timber 45 feet long, marked with brass figures and copper nails, the graduation extending from −5.0 feet to +40.0 feet. The initial point of sounding is the end of the iron bridge, right bank, downstream side. Bench mark No. 1 is 250 feet from the initial point of sounding. The bridge floor is 40.85 feet above the zero of the rod, and the top of the iron girder

under the floor timbers is 39.85 feet above the zero. Bench mark No. 2 is the top of the rail at the depot of the Southern Railway, and is 55.2 feet above gage datum and 190.9 feet above mean sea level. The width of the river at low water is 160 feet. The maximum recorded height of the river was on April 8, 1892, when the gage registered 42 feet. The lowest recorded height was on October 26, 1893, when the gage reading was −3.9 feet. The danger line is at 33 feet. No measurements of discharge were made during 1900.

Daily gage height, in feet, of Tombigbee River at Columbus, Mississippi, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.5	0.4	7.1	4.5	8.0	1.0	19.7	5.8	−1.2	−2.7	+2.6	+3.4
2	2.2	.3	6.8	3.8	6.5	8.0	18.3	4.0	−1.0	−2.8	+4.9	+2.5
3	1.8	.2	5.6	2.7	5.9	10.0	17.6	2.8	−1.0	−3.0	+5.5	+1.9
4	1.6	.4	4.4	1.9	4.5	13.4	16.2	1.9	− .7	−3.1	+5.1	+1.0
5	1.4	1.8	3.8	1.5	2.8	15.3	15.9	1.0	− .6	−3.3	+4.4	+ .1
6	1.2	3.5	3.4	1.3	1.5	17.0	15.4	.0	− .9	−3.5	+3.1	+ .2
7	1.1	3.5	7.6	1.3	.8	20.7	14.5	− .5	−1.3	−3.5	+1.9	+ .3
8	1.0	3.3	14.4	1.1	.5	23.6	13.5	− .9	−1.9	−2.2	+ .9	+ .3
9	.9	4.2	15.1	.7	1.4	25.5	10.0	−1.4	−2.1	−1.0	− .1	.0
10	.9	8.4	13.8	.5	2.3	25.0	6.8	−1.8	−2.3	− .6	− .5	− .3
11	2.0	7.8	11.3	11.7	3.3	23.6	5.5	−2.2	−2.4	− .4	− .9	+ .5
12	6.6	7.6	9.9	16.2	3.6	21.6	4.0	−2.6	−2.5	+2.6	−1.1	− .6
13	8.3	10.2	6.7	17.4	2.8	20.0	3.5	−2.6	−2.6	+4.8	−1.3	+ .9
14	7.1	9.8	4.3	19.3	2.2	18.5	2.0	−2.7	−2.7	+5.2	−1.3	+ .9
15	5.6	8.1	4.8	20.8	1.6	17.8	1.9	−2.2	−2.7	+5.6	−1.4	+ .9
16	4.6	5.8	5.6	20.9	+ .7	17.1	1.5	−2.2	−2.8	+5.4	−1.5	+ .9
17	2.8	4.6	5.2	22.9	.0	17.3	1.0	−2.3	−2.9	+2.4	−1.5	+ .9
18	2.4	3.8	4.6	26.9	− .4	17.8	.5	−2.3	−3.0	+ .4	−1.6	−1.0
19	2.2	3.2	9.4	27.6	−1.0	18.0	.0	−1.8	−3.0	− .4	−1.6	−1.0
20	2.1	2.8	15.6	27.5	− .8	16.8	.4	−1.4	−3.1	− .9	−1.6	−1.0
21	1.9	3.5	18.2	27.1	− .5	15.2	1.3	−1.1	−3.0	−1.1	−1.6	−1.0
22	1.8	5.6	19.0	25.5	− .5	13.5	2.0	−1.6	−2.9	−1.3	+1.2	+3.8
23	1.6	5.4	19.2	23.3	+ .1	13.8	1.9	−1.9	−2.7	−1.0	.0	+5.0
24	1.4	4.5	18.1	21.3	.2	18.5	1.4	−2.0	−1.3	− .2	+1.7	+6.0
25	1.2	5.0	15.2	19.4	.3	21.5	.7	− .1	−1.7	+ .8	+2.8	+6.6
26	1.1	5.0	11.4	17.3	2.3	24.1	.1	+1.2	−2.0	+1.0	+2.8	+6.8
27	.9	3.9	7.8	14.8	2.4	25.0	1.8	+ .6	−2.2	+5.1	+3.3	+6.1
28	.7	4.2	4.6	11.8	2.2	24.8	5.0	− .3	−2.4	+5.6	+3.8	+5.0
29	.6	.....	3.9	9.5	1.6	23.5	5.9	−1.0	−2.5	+4.6	+3.9	+4.2
30	.5	.....	3.1	9.4	1.0	21.7	6.7	−1.4	−2.5	+4.0	+3.8	+4.8
31	.4	.....	3.3	.....	.8	.....	7.2	−1.1	.....	+3.0	.....	+4.0

TOMBIGBEE RIVER NEAR EPES, ALABAMA.

A record of gage heights has been kept at this station for the last ten years by the Alabama Great Southern Railway Company. The gage is painted on the center brick pier of the railway bridge of that company across the Tombigbee a half mile east of Epes, and is referred to two bench marks, the first, the top of the iron girder at the third crossbeam at the station, 80 feet from the right-bank end of the iron bridge, is 64.70 feet above datum of gage, the second, the top of the cross-tie or the base of the rail at the station, 80 feet from the right-bank end of the iron bridge, is 65.50 feet above datum of gage. The west bank of the river is a solid wall of limestone, the east bank is flat and is subject to overflow. The trestle at the east end of the

bridge is seven-eighths of a mile long. The section is good, though the water is very deep and rather swift.

Daily gage height, in feet, of Tombigbee River near Epes, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.5	3.0	18.0	24.5	43.0	6.0	44.5	14.5	2.0	0.5	7.0	8.0
2	7.5	3.0	19.0	19.5	41.0	8.0	44.5	12.0	2.5	.5	8.0	7.5
3	6.5	3.0	18.0	16.0	39.0	15.0	44.5	10.5	2.0	.5	9.0	7.0
4	6.0	3.0	17.0	12.0	33.5	21.0	44.0	8.0	2.0	.5	8.5	6.0
5	5.5	5.0	15.0	10.0	28.0	24.5	42.5	6.0	2.0	.5	8.5	5.0
6	5.0	6.0	14.0	8.0	20.5	27.0	42.0	5.0	2.0	.5	7.5	4.5
7	4.5	7.0	13.0	7.5	16.0	29.5	41.0	5.0	2.0	.5	7.0	4.0
8	4.0	7.5	18.0	7.5	10.0	32.0	40.0	4.0	2.0	.5	5.5	4.0
9	3.5	11.5	21.0	7.0	7.0	34.5	39.0	3.0	2.0	.5	4.5	4.0
10	3.5	13.5	23.0	6.5	7.0	37.0	38.0	2.0	2.0	2.0	4.0	3.5
11	13.0	15.0	24.0	20.5	7.0	38.5	34.0	2.0	1.5	4.0	4.0	3.0
12	20.0	20.5	24.0	26.0	8.0	39.5	26.0	2.0	1.5	6.0	3.0	3.0
13	23.0	26.0	23.0	29.0	8.0	40.5	23.0	2.0	1.5	7.5	3.0	3.5
14	23.5	28.0	20.0	30.0	7.0	41.0	15.5	2.0	2.0	8.5	2.5	3.5
15	22.0	28.0	17.5	31.0	6.0	41.5	13.0	2.0	1.5	10.0	2.0	3.5
16	21.0	26.0	17.0	38.0	6.0	42.0	8.0	1.5	1.0	10.5	2.0	3.5
17	18.5	24.0	18.0	46.0	5.0	42.0	7.0	1.5	1.0	10.0	2.0	3.0
18	15.0	22.0	18.0	48.5	4.0	42.0	6.0	1.5	1.0	7.5	2.0	3.0
19	11.5	18.5	18.5	51.0	3.5	41.5	5.0	1.5	1.0	5.0	2.5	3.0
20	10.0	16.0	26.0	51.5	3.5	41.5	6.5	1.5	.5	4.0	2.5	6.0
21	8.5	14.0	30.0	52.0	3.5	41.5	7.0	1.0	.5	3.5	3.0	5.0
22	8.0	15.0	32.0	52.0	3.5	41.0	8.0	1.0	.5	3.0	3.5	5.0
23	8.0	17.5	34.0	51.5	3.5	41.0	9.0	2.0	.5	2.0	3.5	8.5
24	7.0	18.0	35.5	51.0	4.0	42.5	8.0	1.5	.5	2.0	3.5	10.0
25	6.5	17.5	37.5	49.5	4.5	42.5	6.0	1.5	.5	3.0	6.5	11.5
26	6.0	17.0	38.0	47.5	5.0	43.5	5.5	1.5	.5	4.0	8.5	11.5
27	5.0	16.0	39.0	47.0	6.0	43.5	5.0	5.0	.5	4.5	7.5	12.5
28	3.0	17.0	38.5	46.5	7.0	43.5	5.5	4.5	.5	7.5	7.5	12.0
29	3.0	.....	35.0	46.0	7.0	44.0	14.0	4.0	.5	9.0	8.0	10.0
30	3.0	.....	33.0	44.5	6.0	44.5	14.5	3.0	.5	8.0	8.5	10.0
31	3.0	.....	30.0	.....	5.0	.....	14.5	2.0	.....	7.5	.....	10.5

YOUGHIOGHENY RIVER AT FRIENDSVILLE, MARYLAND.

This station, which was established by E. G. Paul on August 17, 1898, is located at the iron highway bridge connecting the east and west portions of the village. It is described in Water-Supply Paper No. 36, page 159. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 156. During 1900 the following measurements were made by E. G. Paul and C. R. Olberg:

February 15: Gage height, 6.2 feet; discharge, 1,816 second-feet.
June 26: Gage height. 4.6 feet; discharge, 361 second-feet.
September 13: Gage height, 3.8 feet; discharge, 48 second-feet.

Daily gage height, in feet, of Youghiogheny River at Friendsville, Maryland, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.1	4.8	6.3	5.8	4.6	4.3	4.8	4.7	4.0	3.9	4.1	5.3
2	5.1	4.8	6.8	5.8	4.6	4.3	4.8	4.5	4.0	3.9	4.1	5.2
3	5.1	4.8	6.6	5.8	4.5	4.3	4.7	4.3	4.0	3.9	4.1	5.1
4	5.1	4.8	6.3	5.6	4.5	4.4	4.8	4.2	4.0	3.9	4.4	5.3
5	5.1	4.8	6.2	5.5	4.5	4.3	4.6	4.2	4.0	3.9	4.3	5.6
6	5.1	5.4	6.3	5.5	4.6	4.3	4.4	4.2	4.0	3.9	4.2	5.8
7	5.2	5.6	6.1	5.5	4.6	4.2	4.3	4.1	4.0	3.9	4.2	7.5
8	5.3	6.6	6.0	5.4	4.7	4.2	.....	4.1	3.9	3.9	4.2	7.3
9	5.3	6.8	5.8	5.4	4.7	4.2	4.3	4.0	3.9	3.9	4.4	6.9
10	5.3	6.6	5.7	5.3	4.6	4.2	4.2	4.0	3.9	3.9	4.3	6.4
11	5.4	6.4	5.6	5.3	4.5	4.1	4.2	4.0	3.9	3.9	4.3	6.1
12	6.3	6.2	5.5	5.2	4.6	4.1	4.1	4.0	3.9	3.9	4.3	5.8
13	6.3	6.3	5.3	5.1	4.7	4.2	4.1	4.0	3.9	3.9	4.3	5.6
14	6.0	6.4	5.3	5.0	4.7	4.5	4.1	4.0	3.9	4.1	4.3	5.4
15	5.8	6.3	5.3	5.0	4.8	4.7	4.1	4.1	3.9	4.3	4.2	5.4
16	5.8	6.1	5.4	4.9	4.9	5.4	4.1	4.2	3.8	4.3	4.2	5.3
17	5.6	5.8	5.3	4.9	4.9	6.7	4.0	4.5	3.8	4.2	4.2	5.2
18	5.6	5.6	5.5	4.8	4.8	7.1	4.0	4.5	3.8	4.2	4.3	5.1
19	5.6	5.2	5.7	4.8	4.7	7.0	4.0	4.4	8.8	4.2	4.4	4.9
20	5.7	5.1	5.9	4.7	4.7	6.5	4.1	4.3	3.8	4.1	4.4	4.7
21	6.0	5.1	7.0	4.7	4.7	6.0	4.1	4.2	3.8	4.2	4.5	4.6
22	6.3	5.0	6.5	4.7	4.7	5.3	4.2	4.2	3.8	4.2	4.7	4.6
23	6.1	5.0	6.1	4.6	4.7	4.8	4.3	4.6	3.8	4.1	4.8	4.5
24	5.7	5.0	5.8	4.6	4.6	4.7	4.3	4.2	3.8	4.0	4.9	4.3
25	5.5	5.0	5.6	4.7	4.5	4.7	4.4	4.3	3.8	4.0	5.2	4.3
26	5.4	5.0	5.5	4.7	4.4	4.6	4.7	4.3	3.8	4.0	9.5	4.4
27	5.3	5.1	5.4	4.8	4.4	4.5	5.0	4.1	3.9	4.1	8.3	4.6
28	5.2	5.1	5.4	4.8	4.4	4.6	4.6	4.1	3.9	4.2	6.9	4.8
29	5.0	.....	5.5	4.7	4.4	4.8	4.7	4.2	3.9	4.1	5.8	5.0
30	5.0	.....	5.7	4.7	4.4	4.9	4.9	4.1	3.9	4.1	5.5	5.2
31	5.0	.....	5.7	.....	4.4	.....	5.5	4.1	.....	4.1	.....	5.2

CHEAT RIVER NEAR UNEVA, WEST VIRGINIA.

This station was established July 8, 1899. As there is no bridge at the place convenient for making measurements, a cable of 600 feet span was stretched across the stream 6 miles northwest of Morgantown, near Uneva, West Virginia. The station is described in Water-Supply Paper No. 36, page 160. During 1900 one measurement was made by E. G. Paul, as follows:

June 25: Gage height, 2.80 feet; discharge, 1,403 second-feet.

Daily gage height, in feet, of Cheat River near Uneva, West Virginia, for 1900.

Day.	July.	Aug.	Sept	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.2	3.2	2.3	2.1	1.6	.....	17	2.8	1.6	1.4	1.4	2.2	2.9
2	2.8	3.1	2.1	2.0	1.6	4.0	18	2.9	1.5	1.4	1.4	2.1	2.8
3	2.7	2.9	2.0	1.9	1.7	4.0	19	2.9	1.5	1.4	1.5	2.2	2.8
4	2.6	2.7	1.9	1.8	1.7	4.3	20	3.0	1.6	1.4	1.4	3.0	2.7
5	2.6	2.6	1.6	1.7	1.6	7.0	21	3.0	2.0	1.3	1.3	3.3	2.7
6	2.4	2.4	1.5	1.6	2.0	7.0	22	3.0	1.9	1.5	1.3	3.5	2.6
7	2.3	2.4	1.4	1.5	2.3	6.0	23	2.9	1.8	1.5	1.3	3.8	3.0
8	3.0	2.3	1.4	1.6	2.5	5.0	24	3.5	1.8	1.4	2.3	4.0	3.2
9	2.9	2.0	1.4	1.7	2.4	4.4	25	4.8	1.8	1.4	2.3	.....	3.3
10	2.9	2.0	1.4	1.7	2.2	4.7	26	5.1	1.8	1.5	2.2	.....	3.3
11	2.8	2.0	1.4	1.7	2.0	3.4	27	5.2	1.7	1.3	2.1	.....	3.2
12	2.7	1.8	1.4	1.7	1.9	3.4	28	4.9	1.7	1.3	2.0	.....	3.1
13	2.6	1.7	1.3	1.6	1.9	3.2	29	3.7	2.0	1.4	1.8	.....	3.1
14	2.5	1.7	1.3	1.5	1.9	3.0	30	3.4	2.3	1.4	1.7	.....	.....
15	2.6	1.7	1.3	1.5	2.0	3.0	31	3.2	2.3	.....	1.6	.....	.....
16	2.6	1.6	1.1	1.4	2.2	3.0							

NEW RIVER AT RADFORD, VIRGINIA.

This station, which was established by D. C. Humphreys on August 1, 1898, the gage having been erected by the United States Weather Bureau, is described in Water-Supply Paper No. 36, page 161. On account of the inaccuracies of the Weather Bureau gage, a wire gage was put in February 23, 1900, the zero being on the same level as that of the old gage. The observer is T. M. Brady. Records of measurements for 1899 will be found in Water-Supply Paper No. 36, page 162. During 1900 the following measurements were made by D. C. Humphreys:

February 23: Gage height, 2.55 feet; discharge, 11,681 second-feet.
February 24: Gage height, 2.10 feet; discharge, 8,500 second-feet.
March 30: Gage height, 1.78 feet; discharge, 7,709 second-feet.
June 27: Gage height, 1.62 feet; discharge, 6,749 second-feet.
July 28: Gage height, 1.25 feet; discharge, 5,256 second-feet.
August 22: Gage height, 0.00; discharge, 1,365 second-feet.
December 20: Gage height, 0.70 foot; discharge, 2,975 second-feet.

Daily gage height, in feet, of New River at Radford, Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.20	0.30	5.85	1.90	1.20	0.80	1.00	0.40	-0.30	-0.40	0.90	1.60
2	.20	.80	6.60	1.20	1.10	.70	.80	.30	-.30	-.40	.80	1.00
3	.20	.90	3.20	1.20	1.00	1.00	.60	.20	-.40	.00	.80	1.00
4	.20	.80	2.10	1.10	1.30	1.00	.70	.30	-.30	.00	1.00	1.60
5	.20	.80	2.00	1.20	1.20	.90	.90	.30	-.30	.00	1.40	4.50
6	.20	.70	1.90	1.10	1.00	.90	.70	.00	-.80	.10	1.20	3.00
7	.30	1.00	1.80	1.00	1.00	.80	.50	.00	-.70	.10	1.00	2.00
8	.30	1.20	2.10	1.00	.90	.90	.37	-.20	-.70	.20	.90	2.00
9	.40	.90	2.20	.90	1.00	.80	.34	-.40	-.60	.20	.80	2.10
10	.50	1.00	2.00	1.00	1.30	.80	.50	-.70	-.40	.30	.80	2.00
11	.70	.90	2.70	1.90	1.00	.70	.36	-.90	-.30	.20	.70	1.30
12	1.00	1.20	2.60	1.80	1.00	.70	.42	-.00	-.50	.00	.60	1.40
13	3.00	2.00	2.00	1.20	1.00	.80	.28	-.50	-.40	.00	.60	1.00
14	1.90	4.80	1.80	1.00	.90	1.00	.14	-.80	-.40	.20	.50	1.00
15	1.60	2.80	1.70	.90	.90	1.10	.20	-.70	1.00	.30	.60	.90
16	1.20	1.70	1.40	.80	.80	1.20	.28	-.60	2.85	.30	.50	.90
17	.90	1.50	1.70	.80	.80	1.60	.26	-.80	2.40	.20	.40	.80
18	.80	1.40	1.60	.70	.80	1.20	.14	-.80	1.20	.10	.40	.80
19	1.00	1.30	1.30	4.00	.90	2.00	.02	-.70	.50	.00	.30	.70
20	2.40	.90	3.95	2.60	.80	1.40	.00	-.70	.20	.00	.30	.70
21	1.90	1.00	4.50	2.30	1.00	1.10	.08	-.60	.40	.00	.40	.60
22	1.80	3.00	3.30	2.70	.90	1.00	.16	.00	.50	.30	.50	.60
23	1.60	2.90	2.40	2.90	.90	1.20	.24	.00	.50	6.83	.50	.80
24	1.30	2.20	2.20	2.30	.80	1.00	.42	.10	.50	23.00	.40	.70
25	1.20	2.10	2.10	1.90	2.00	2.00	.50	.20	.40	4.60	.50	1.00
26	1.00	1.90	1.90	1.70	1.90	1.60	.58	.20	.30	2.30	7.80	.90
27	.90	1.00	2.60	1.60	1.00	2.00	.86	.00	.20	1.30	4.30	.70
28	.30	2.60	2.40	1.40	1.10	1.60	2.20	.00	.00	1.20	2.40	.80
29	.20	.....	1.90	1.30	1.00	1.80	.80	.00	-.30	1.20	1.90	.70
30	.20	.....	1.70	1.20	.90	1.60	.90	-.20	.40	1.00	1.80	.60
31	.30	.....	1.00	.....	.90	.....	.50	-.20	.....	1.03	.....	.70

GREENBRIER RIVER AT ALDERSON, WEST VIRGINIA.

This station, which was established by C. C. Babb and D. C. Humphreys on August 1, 1895, is described in Water-Supply Paper No. 36, page 163. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 159. During 1900 the following measurements were made by D. C. Humphreys:

March 31: Gage height, 4.07 feet; discharge, 5,128 second-feet.
June 29: Gage height, 1.99 feet; discharge, 564 second-feet.

July 24: Gage height, 1.97 feet; discharge, 493 second-feet.
August 20: Gage height, 1.38 feet; discharge, 148 second-feet.
December 21: Gage height, 2.24 feet; discharge, 834 second-feet.

Daily gage height, in feet, of Greenbrier River at Alderson, West Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.15	3.98	3.90	2.30	2.25	2.75	2.45	1.55	1.40	1.45	3.00
2	1.88	1.85	6.81	3.48	2.25	2.15	3.00	2.15	1.53	1.50	1.58	2.75
3	1.88	1.95	5.08	3.30	2.18	2.10	2.45	2.00	1.48	1.45	1.60	2.58
4	1.88	1.95	4.00	3.20	2.15	2.20	2.40	1.90	1.45	1.43	3.20	3.48
5	1.90	1.95	3.58	3.08	2.10	2.13	2.08	1.80	1.40	1.40	2.75	7.00
6	1.86	2.10	3.55	3.00	2.05	2.05	2.00	1.70	1.38	1.38	2.25	5.15
7	1.85	2.40	4.53	2.88	2.02	1.98	1.90	1.42	1.35	1.37	2.05	4.00
8	1.85	2.60	4.90	2.80	2.00	1.90	1.98	1.60	1.30	1.35	1.93	3.55
9	1.85	3.75	4.20	3.00	1.95	1.90	1.93	1.57	1.28	1.38	1.90	3.40
10	2.05	4.25	3.70	3.02	2.10	1.88	1.78	1.55	1.27	1.37	1.80	3.40
11	2.05	3.45	3.45	2.85	2.00	1.82	1.73	1.52	1.25	1.35	1.72	3.15
12	2.17	3.10	3.17	2.65	1.95	1.75	1.65	1.48	1.23	1.35	1.75	2.92
13	4.18	7.24	3.00	2.55	1.97	1.68	1.63	1.45	1.20	1.33	1.75	2.73
14	3.15	7.90	2.90	2.50	1.92	1.70	1.60	1.40	1.20	1.45	1.85	2.65
15	2.80	5.05	2.93	2.37	1.85	2.05	1.55	1.40	1.31	1.70	1.80	2.55
16	2.53	4.00	2.87	2.30	1.83	2.28	1.52	1.40	1.88	1.70	1.78	2.45
17	2.38	3.48	2.85	2.20	1.80	3.20	1.45	1.35	1.65	1.60	1.75	2.30
18	2.40	3.10	2.60	2.40	1.77	5.23	1.45	1.37	1.50	1.55	1.68	2.25
19	2.65	2.65	2.89	2.52	1.73	4.40	1.45	1.40	1.45	1.50	1.65	2.25
20	5.98	2.50	8.12	3.40	1.80	3.50	1.42	1.37	1.40	1.45	1.62	2.20
21	5.65	2.55	8.23	3.55	2.90	3.00	1.42	1.40	1.38	1.45	1.60	2.23
22	4.33	4.05	5.50	3.65	2.50	2.65	1.48	1.40	1.43	1.43	1.72	2.20
23	3.45	5.40	4.50	3.73	2.32	2.45	2.10	1.50	1.50	2.47	2.43	2.08
24	3.03	4.37	3.40	3.45	2.20	2.25	2.20	1.40	1.63	3.68	3.38	2.05
25	2.75	3.75	4.85	3.16	2.20	2.15	2.27	1.45	1.50	2.60	3.68	2.18
26	2.55	3.53	4.60	2.92	2.50	2.07	2.44	1.40	1.53	2.45	18.23	2.23
27	2.43	3.20	4.75	2.75	2.45	2.05	3.97	1.50	1.45	2.25	9.30	2.18
28	2.25	2.83	4.13	2.20	2.20	1.95	3.90	1.50	1.40	2.00	5.08	2.13
29	2.08	.....	4.05	2.45	2.20	1.95	2.90	1.55	1.45	1.75	4.00	2.12
30	2.45	.....	3.80	2.40	2.40	2.00	2.50	1.60	1.40	1.70	3.37	2.38
31	2.05	.....	4.10	.....	2.40	.....	2.48	1.50	.....	1.63	.....	2.35

NORTH FORK OF NEW RIVER AT WEAVERSFORD, NORTH CAROLINA.

During the summer of 1900 a special investigation of the hydrographic conditions of the southern Appalachian region was made by the United States Geological Survey. Temporary stations were established on several of the largest rivers, among these being the North Fork and the South Fork of New River. A station was also established on New River near Oldtown, Virginia. The regular station on New River, which is at Fayette, West Virginia, has been continued. Descriptions of these temporary stations and the gage heights obtained are given on the following pages.

The station at Weaversford was established July 27, 1900, by Cleveland Abbe, jr., and N. C. Curtis. The nearest railroad station is at North Wilkesboro, 40 miles distant, and the Weaversford post-office is a fourth of a mile from the gaging station, which can only be reached by private conveyance. The gage rod is 12.6 feet long, and is divided into feet and tenths. It is nailed to the downstream vertical timber of the forebay of Dixon's mill. The discharge measurements are made by wading at a comparatively shallow ford, not much used and not on a public highway, located 400 yards below the house of Mr. Dixon, the owner of the mill. The initial point of sounding is on the right bank, at the outer edge of a fence post opposite the ford where measurements are made. The banks are high and have been overflowed only

once, viz, in 1878. The bed of the stream is rocky and gravelly, and is constant in form. The observer is C. L. Nelson, post-office address Weaversford, Ashe County, North Carolina. The gage heights for 1900 will be published next year. During 1900 the following measurements were made by N. C. Curtis and Cleveland Abbe, jr.:

July 23: Gage height, 0.60 foot; discharge, 536 second-feet.
October 27: Gage height, 0.90 foot; discharge, 708 second-feet.

SOUTH FORK OF NEW RIVER AT NEW RIVER, NORTH CAROLINA.

This station was established July 28, 1900, by Cleveland Abbe, jr., and N. C. Curtis. The nearest railroad station is North Wilkesboro, 30 miles distant, and the gaging station can only be reached by private conveyance. The discharge measurements are made by wading across a ford a half mile above the confluence of the North and South forks of New River and about 1 mile downstream from the gage at Warden's store. The gage is a wire cord running over a bolt driven into a locust tree, and reads on a horizontal scale divided into feet and tenths. The pointer or index on the gage wire is 10.55 feet from the extreme tip of the double window-sash weights which are attached. When the latter rest on the bottom, the index stands opposite 1 foot on the scale, which is read direct. The initial point of sounding is a notch on the stream side of the second small poplar on the left of the road going toward the stream and opposite the ford. The channel is straight, the current fairly swift, and the banks are low and seldom overflow. The bed of the stream is rocky, with bowlders and cobbles. The drainage area at this station is 326.5 square miles. The observer is F. R. Warden, a storekeeper located about 75 yards downstream from the gage. During 1900 the following measurements were made by N. C. Curtis and Cleveland Abbe, jr.:

July 28: Gage height, 2.7 feet; discharge, 751 second-feet.
October 28: Gage height, 2.6 feet; discharge, 1,635 second-feet.

Daily gage height, in feet, of South Fork of New River at New River, North Carolina, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.45	2.30	2.30	2.60	2.70	17	.....	2.20	2.80	2.25	2.40	2.60
2	.....	2.35	2.25	2.30	2.60	2.70	18	.....	2.20	2.40	2.20	2.40	2.60
3	.....	2.30	2.20	2.45	3.50	2.70	19	.....	2.20	2.40	2.20	2.40	2.60
4	.....	2.30	2.20	2.80	3.80	3.95	20	.....	2.20	2.30	2.20	2.40	2.60
5	.....	2.30	2.20	2.75	3.30	3.70	21	.....	2.20	2.30	2.20	2.35	2.60
6	.....	2.30	2.20	2.70	2.80	3.20	22	.....	2.30	2.30	2.20	2.30	2.60
7	.....	2.30	2.20	2.55	2.65	2.85	23	.....	2.30	2.30	7.90	2.30	2.70
8	.....	2.30	2.20	2.50	2.60	2.80	24	.....	2.30	2.30	6.70	2.30	2.60
9	.....	2.30	2.20	2.45	2.60	2.80	25	.....	2.30	2.30	3.75	2.70	2.60
10	.....	2.30	2.20	2.40	2.60	2.75	26	.....	2.25	2.30	3.05	5.20	2.60
11	.....	2.30	2.20	2.45	2.60	2.70	27	.....	2.20	2.30	2.90	3.60	2.60
12	.....	2.30	2.15	2.35	2.55	2.70	28	.....	2.20	2.30	2.70	3.05	2.60
13	.....	2.35	2.10	2.30	2.50	2.60	29	2.65	2.50	2.30	2.60	2.95	2.60
14	.....	2.40	2.55	2.30	2.50	2.60	30	2.50	2.45	2.30	2.60	2.80	2.60
15	.....	2.35	2.60	2.30	2.45	2.60	31	2.50	2.35	.....	2.60	.....	2.80
16	.....	2.30	3.70	2.30	2.40	2.60							

NEW RIVER NEAR OLDTOWN, VIRGINIA.

This station, which was established by Cleveland Abbe, jr., and N. C. Curtis, July 31, 1900, is located about 2 miles west of Oldtown, and can only be reached by private conveyance. Oldtown is 30 miles from the railroad at Mount Airy, and 9 miles from a branch of the Norfolk and Western Railway. The wire gage is suspended from an overhanging tree on the left bank, 50 yards upstream from the ferry. The horizontal scale is so placed that the zero mark is next to the bank. The distance from the index on the wire to the bottom of the weight is 16.1 feet. The initial point of sounding is on the right bank, and is a notch cut in the wooden upright of the beam supporting the north end of the ferry cable. The channel above and below the station is straight and the current is fairly swift. The right bank is rather low and is subject to overflow. The left bank is rarely submerged in flood. The bed of the stream is rocky and sandy. The observer is Joshua Austin, a farmer of Oldtown. During 1900 the following measurements were made by N. C. Curtis and Cleveland Abbe, jr.:

July 31: Gage height, 6.6 feet; discharge, 1,541 second-feet.
October 29: Gage height, 6.3 feet; discharge, 2,293 second-feet.

Daily gage height, in feet, of New River near Oldtown, Virginia, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.70	.....	6.90	6.60	6.30	17	6.10	5.80	6.90	6.80	6.50
2	6.70	6.80	6.80	6.60	6.30	18	7.00	6.50	6.10	6.80	6.60
3	6.80	6.90	6.70	5.40	6.50	19	7.00	6.80	6.10	6.80	6.60
4	6.90	7.00	6.60	5.10	5.80	20	7.10	6.90	6.10	6.80	6.70
5	6.90	7.10	6.40	5.60	4.60	21	6.90	6.80	6.10	6.80	6.70
6	6.90	7.10	6.40	5.10	5.50	22	6.90	6.80	6.10	6.70	6.50
7	6.90	7.10	6.50	6.30	5.80	23	6.50	6.80	6.10	6.70	6.50
8	6.80	7.10	6.60	6.40	5.90	24	6.60	6.70	1.20	6.60	6.50
9	7.00	7.20	6.70	6.50	5.90	25	6.70	6.80	4.30	6.60	6.80
10	7.10	7.20	6.70	6.50	6.00	26	6.90	6.50	5.40	2.40	6.70
11	7.10	7.20	6.80	6.50	6.10	27	6.10	6.80	5.90	4.60	6.70
12	7.20	7.20	6.90	6.60	6.20	28	6.10	6.90	6.10	5.80	6.70
13	7.20	7.20	6.90	6.70	6.30	29	7.00	6.90	6.30	5.10	6.70
14	7.20	6.80	6.80	6.60	6.30	30	6.30	.....	6.30	6.20	6.30
15	6.70	5.70	6.90	6.60	6.50	31	6.60	.....	6.50	.....	6.40
16	6.80	3.90	6.90	6.70	6.50						

NEW RIVER AT FAYETTE, WEST VIRGINIA.

This station, which was established July 29, 1895, is just above the mouth of Wolf Creek, on the one-span highway bridge at Fayette, West Virginia. It is described in Water-Supply Paper No. 36, page 164. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 157. During 1900 the following measurements were made by D. C. Humphreys:

March 31: Gage height, 8.49 feet; discharge, 17,387 second-feet.
June 29: Gage height, 5.58 feet; discharge, 11,436 second-feet.
July 25: Gage height, 2.47 feet; discharge, 4,625 second-feet.
August 20: Gage height, 0.55 foot; discharge, 2,275 second-feet.
December 21: Gage height, 3.40 feet; discharge, 5,915 second-feet.

Daily gage height, in feet, of New River at Fayette, West Virginia, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.95	3.95	7.80	8.30	4.50	4.30	6.60	3.00	0.90	1.10	3.50	(a)
2	3.20	3.60	12.50	7.50	4.40	3.60	6.15	2.20	.90	.95	3.70	(a)
3	3.40	3.55	8.15	6.90	4.10	3.30	5.30	1.40	.90	.80	3.00	(a)
4	3.10	3.50	6.40	6.50	4.00	3.00	4.00	1.00	.80	.80	2.80	(a)
5	3.10	3.40	5.55	6.20	4.00	4.00	3.10	.70	.80	.75	2.65	(a)
6	3.00	3.45	4.05	5.70	3.95	3.50	2.70	.50	.70	1.10	2.90	(a)
7	3.05	3.30	4.10	5.40	3.85	3.30	2.90	.25	.70	1.10	3.25	(a)
8	3.10	3.05	3.80	5.00	3.85	3.00	2.10	.10	.70	1.45	3.40	(a)
9	3.40	3.00	3.50	4.85	3.90	2.65	1.80	.10	.60	1.70	3.80	(a)
10	3.60	3.20	3.45	4.95	4.00	2.50	1.45	.00	.75	1.80	4.00	(a)
11	4.10	3.40	3.90	4.75	4.50	2.40	1.10	.90	.80	1.60	3.75	(a)
12	4.44	4.05	4.05	4.40	4.60	2.20	.90	.60	.85	1.35	3.60	(a)
13	6.20	4.20	4.00	4.25	4.25	3.45	.80	.30	.75	1.40	3.45	(a)
14	5.45	11.25	4.00	4.30	3.85	3.60	.70	.20	.90	2.05	3.35	(a)
15	5.30	9.60	5.10	4.20	3.55	3.50	.60	.10	.80	2.25	3.10	(a)
16	5.00	7.05	5.75	3.80	3.25	8.20	.60	.10	.00	2.00	3.00	(a)
17	4.70	3.40	5.85	3.60	3.15	10.40	.60	.20	6.15	1.85	2.70	(a)
18	4.40	3.55	6.20	3.40	2.90	11.00	.50	.20	7.80	3.05	2.50	(a)
19	4.30	4.10	7.85	3.80	4.50	10.50	.80	.10	6.00	3.20	2.40	(a)
20	5.45	4.05	10.40	10.20	4.45	8.50	.90	.30	5.40	2.95	2.30	(a)
21	8.75	5.10	13.60	8.50	4.10	6.80	.90	.20	5.05	3.15	3.10	(a)
22	6.40	5.40	12.30	8.00	4.60	6.30	.75	.40	4.60	3.15	4.40	(a)
23	4.40	7.30	9.90	9.80	4.10	6.00	.50	.40	4.30	2.90	5.80	(a)
24	3.25	6.55	7.45	9.30	3.50	5.80	2.10	.50	2.85	16.05	6.60	2.50
25	3.60	5.60	5.95	7.85	4.00	5.60	2.70	.70	2.50	18.10	.....	2.80
26	3.35	6.10	5.15	6.85	6.55	5.25	2.90	1.00	2.05	13.30	25.00	3.00
27	3.50	5.30	4.90	6.10	6.05	5.00	5.00	1.15	1.40	10.00	(a)	3.20
28	3.60	4.20	7.50	5.50	5.30	4.70	6.20	1.30	1.25	6.50	(a)	3.50
29	3.75	.....	9.65	5.00	4.60	5.50	6.50	1.50	1.15	5.00	(a)	3.90
30	4.20	.....	8.60	4.60	4.25	6.75	5.00	2.00	1.90	4.75	(a)	3.90
31	4.05	.....	8.50	.....	4.90	.....	3.80	1.40	.....	4.00	.....	4.10

a Gage broken; no record.

SOUTH FORK OF HOLSTON RIVER AT BLUFF CITY, TENNESSEE.

This station was originally established by the United States Weather Bureau at the highway bridge at Bluff City. Readings were begun July 17, 1900, by the United States Geological Survey, in connection with the general hydrographic investigation of the southern Appalachian region. The gage is a 4-inch by 8-inch timber bolted to the downstream side of the stone pier. The initial point of sounding is on the north end of the bridge, downstream side. The channel is straight for about 500 feet above and below the bridge, and the current is swift. The north bank is high, but the south bank is subject to overflow at the bridge. The bed is rocky and constant in section. The drainage area is 828.1 square miles. O. V. Cox is the observer. During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

July 17: Gage height, 0.25 foot; discharge, 378 second-feet.
August 16: Gage height, 0.25 foot; discharge, 329 second-feet.
September 25: Gage height, 1.15 feet; discharge, 791 second-feet.
November 8: Gage height, 0.90 foot; discharge, 681 second-feet.
December 27: Gage height, 0.60 foot; discharge, 392 second-feet.

Daily gage height, in feet, of South Fork of Holston River at Bluff City, Tennessee, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	------	------	0.30	0.45	0.65	1.40	17	0.40	0.20	1.70	0.20	0.45	1.00
2	------	------	.25	.40	.60	1.20	18	.40	.20	.90	.10	.40	.80
3	------	------	.25	.30	.60	1.10	19	.40	.20	.60	.10	.50	.80
4	------	------	.25	.20	1.70	2.55	20	.40	.20	.50	.10	.55	.75
5	------	------	.20	.20	1.80	4.35	21	.40	1.00	.50	.10	.55	.75
6	------	------	.20	.10	1.50	3.20	22	.40	1.50	.20	.40	.55	.70
7	------	------	.20	.10	1.40	2.70	23	.40	1.40	.90	.45	.60	.70
8	------	------	.15	.30	1.00	1.50	24	.40	.60	1.10	2.60	.90	.70
9	------	------	.15	.30	.80	1.70	25	.60	.40	1.00	1.90	1.30	.70
10	------	------	.10	.25	.80	1.50	26	2.00	.35	.90	1.60	4.30	.70
11	------	0.60	.10	.25	.80	1.50	27	3.70	.30	.70	1.30	3.70	.60
12	------	.45	.10	.20	.80	1.40	28	1.80	.25	.70	1.20	2.50	.60
13	------	.35	.10	.20	.80	1.40	29	------	.20	.70	1.10	1.90	.60
14	------	.30	.05	.20	.70	1.30	30	------	1.20	.40	.70	1.60	.60
15	------	.25	2.00	.20	.60	1.30	31	------	.60	------	.70	------	.80
16	------	.25	3.00	.25	.50	1.20							

WATAUGA RIVER AT BUTLER, TENNESSEE.

In connection with the general hydrographic investigation of the southern Appalachian region, stations were established on Watauga River and on Roan Creek at Butler, Tennessee; also on Elk Creek at Lineback, Tennessee. Descriptions of these stations and records of the gage heights and discharge measurements are given on the following pages. The station on Watauga River at Butler is about 100 yards below the mouth of Roan Creek. It was established August 14, 1900. The gage rod, which is graduated to feet and tenths, is nailed to a tree on the right bank. Measurements are made from the highway bridge. The initial point of sounding is at the downstream end of the guard rail. The channel is straight above and below the station, and the current is swift. The banks are high, and the bed is sandy and rocky. The drainage area is 261 square miles. The observer is Edgar L. Shull. During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

July 30: Gage height, 1.37 feet; discharge, 434 second-feet.
August 7: Gage height, 0.90 foot; discharge, 214 second-feet.
August 17: Gage height, 0.84 foot; discharge, 166 second-feet.
October 6: Gage height, 1.12 feet; discharge, 238 second-feet.
November 7: Gage height, 2.20 feet; discharge, 591 second-feet.
December 28: Gage height, 1.40 feet; discharge, 311 second-feet.

Daily gage height, in feet, of Watauga River at Butler, Tennessee, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	------	0.90	0.90	5.60	2.00	17	------	4.50	0.70	1.50	1.50
2	------	.90	.90	5.00	2.40	18	0.90	4.00	.70	1.50	1.50
3	------	.90	.90	2.30	2.40	19	.80	3.20	.70	1.40	1.50
4	------	.90	.90	2.10	5.00	20	.80	2.70	.70	1.40	1.50
5	------	.90	.90	2.50	4.00	21	1.10	1.10	.70	1.40	1.50
6	------	.90	.90	2.30	3.50	22	1.60	1.00	.70	1.40	1.50
7	------	.80	.90	2.00	3.00	23	1.30	1.10	15.00	1.40	1.50
8	------	.80	.90	2.00	2.50	24	1.20	.90	9.00	1.40	1.50
9	------	.80	.90	1.90	2.10	25	.90	.90	4.50	1.40	1.50
10	------	.80	.90	1.90	1.90	26	.90	.90	2.50	5.40	1.50
11	------	.80	.90	1.90	1.50	27	.90	.90	2.00	4.00	1.50
12	------	.80	.80	1.80	1.50	28	.90	.90	4.50	3.00	1.50
13	------	.80	.80	1.60	1.50	29	.80	.90	4.00	3.00	1.50
14	1.30	1.70	.90	1.50	1.50	30	1.90	.90	4.00	2.40	1.50
15	.80	1.70	.80	1.50	1.50	31	1.40	------	3.20	------	1.50
16	.70	3.10	.70	1.50	1.50						

ROAN CREEK AT BUTLER, TENNESSEE.

This station was established August 8, 1900. The gage is a vertical rod nailed to a tree on the left bank of the stream, at Cole & Scott's gristmill, about a half mile above the mouth of the creek. Measurements are made from the highway bridge at the mouth of the creek, the initial point of sounding being on the right bank, at the end of the upstream guard rail. The left bank is low and is subject to overflow. The bed is composed of sand and mud. The drainage area is 163.6 square miles. The observer is W. N. Bridges, of Butler.

During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

July 30: Gage height, 1.47 feet; discharge, 137 second-feet.
August 7: Gage height, 1.02 feet; discharge, 65 second-feet.
August 17: Gage height, 0.85 foot; discharge, 58 second-feet.
October 6: Gage height, 0.86 foot; discharge, 52 second-feet.
November 7: Gage height, 1.50 feet; discharge, 171 second-feet.
December 28: Gage height, 1.20 feet; discharge, 82 second-feet.

Daily gage height, in feet, of Roan Creek at Butler, Tennessee, for 1900.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1		0.95	1.00	12	0.78	0.73	0.87	23	1.27	1.20	4.80
2		1.00	.85	13	.85	.75	.90	24	1.00	1.25	
3		.83	.85	14	1.20	1.00	.85	25	.90	1.05	
4		.88	.85	15	.93	1.65	.88	26	.90	.95	
5		.83	.80	16	.86	2.50	.82	27	.84	.98	
6		.81	.86	17	.84	1.30	.80	28	.86	.91	
7		.80	.80	18	.85	1.05	.80	29	.91	.95	
8	0.90	.76	.83	19	.80	1.00	.80	30	1.32	1.30	
9	.72	.80	.89	20	.82	.93	.81	31	1.05		
10	.82	.75	.88	21	1.05	.92	.78				
11	.78	.75	.83	22	1.71	.95	.80				

ELK CREEK AT LINEBACK, TENNESSEE.

This station was established August 8, 1900. The gage rod is nailed to a tree on the left bank, 100 yards below the Lineback post-office. Gagings are made by wading. The banks are low and are subject to overflow. The channel is straight and the current is swift. The drainage area is 80.4 square miles. The observer is Dove Lineback, of Lineback, Tennessee. During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

August 9: Gage height, 3.5 feet; discharge, 70 second-feet.
August 17: Gage height, 3.5 feet; discharge, 56 second-feet.
October 6: Gage height, 3.5 feet; discharge, 53 second-feet.

Daily gage height, in feet, of Elk Creek at Lineback, Tennessee, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.60	3.40	4.00	5.30	17	3.50	4.00	3.40	3.90	4.00
2	.....	3.50	3.40	3.90	5.30	18	3.50	3.80	3.40	3.80	4.00
3	.....	3.50	3.40	5.30	5.30	19	3.40	3.70	3.30	3.80	4.30
4	.....	3.50	3.60	5.60	5.80	20	3.50	3.60	3.30	3.80	4.20
5	.....	3.40	3.60	5.30	4.80	21	4.00	3.60	3.30	3.80	4.10
6	.....	3.50	3.50	4.50	4.60	22	3.90	3.60	3.30	3.80	4.00
7	.....	3.50	3.50	4.30	4.50	23	3.40	3.60	11.00	3.80	4.00
8	3.50	3.40	3.50	4.20	4.40	24	3.40	3.60	5.60	3.90	4.00
9	3.50	3.40	3.50	4.00	4.30	25	3.40	3.60	5.50	3.90	4.20
10	3.50	3.40	3.40	4.00	4.20	26	3.40	3.50	5.40	6.30	4.30
11	3.50	3.30	3.50	4.00	4.40	27	3.40	3.50	5.30	5.70	4.20
12	3.50	3.30	3.60	4.00	4.40	28	3.50	3.50	4.70	4.70	4.10
13	3.50	3.40	3.50	4.00	4.30	29	3.50	3.40	4.50	5.50	4.00
14	3.70	3.80	3.50	4.00	4.20	30	4.00	3.40	4.00	3.60	4.20
15	3.60	4.30	3.40	3.90	4.00	31	3.90	.....	4.00	.....	4.40
16	3.50	4.30	3.40	3.90	4.00						

NOLICHUCKY RIVER NEAR CHUCKY VALLEY, TENNESSEE.

This station was established September 6, 1900, at the highway bridge 1 mile above Chucky Valley, as an aid in the general hydrographic investigations of the southern Appalachian region made during the summer of 1900. The wire gage is suspended from the upstream side of the bridge, and is referred to a scale on the guard rail. The initial point of sounding is at the end of the lower guard rail on the left bank, downstream side. The banks are high, the current is sluggish, and the bed is sandy. The stream is straight above and below the station. The drainage area is 817 square miles. The observer is Byrd Bayless, Chucky Valley, Tennessee. During 1900 the following measurements were made by L. V. Branch and E. W. Myers:

September 5: Gage height, 2 feet; discharge, 302 second-feet.
September 20: Gage height, 2.18 feet; discharge, 442 second-feet.
October 15: Gage height, 2 feet; discharge, 378 second-feet.
November 10: Gage height, 2.90 feet; discharge, 919 second-feet.

Daily gage height, in feet, of Nolichucky River near Chucky Valley, Tennessee, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	1.80	2.50	3.10	17	3.10	2.00	2.50	2.70
2	.....	1.90	2.60	3.20	18	2.60	1.90	2.50	2.70
3	.....	1.90	3.00	3.00	19	2.30	2.00	2.40	2.60
4	.....	2.00	5.20	4.80	20	2.10	1.90	2.40	2.60
5	2.00	3.30	4.00	3.30	21	2.00	1.90	2.30	2.90
6	2.00	3.20	3.50	3.50	22	2.00	1.90	2.50	2.80
7	2.00	2.50	3.20	3.40	23	2.20	9.30	2.50	2.90
8	2.00	2.30	2.50	3.30	24	2.20	5.20	2.50	3.00
9	1.80	2.30	3.00	3.30	25	2.10	3.90	2.70	3.00
10	1.80	2.20	2.90	3.20	26	2.10	3.30	6.50	3.20
11	1.80	2.10	2.80	3.10	27	2.10	3.10	4.50	3.10
12	1.80	2.10	2.80	3.00	28	2.00	2.90	3.40	3.00
13	1.80	2.10	2.70	3.00	29	2.00	2.80	3.40	2.90
14	2.60	2.00	2.70	2.90	30	1.80	2.70	3.20	3.00
15	2.30	2.00	2.60	2.90	31	.....	2.60	.....	3.20
16	4.70	2.00	2.50	2.80					

FRENCH BROAD RIVER NEAR ASHEVILLE, NORTH CAROLINA.

This station, which was established by C. C. Babb in September, 1895, is located at the Bingham School iron highway bridge, 3 miles west of Asheville, and is reached by electric car from that place. It is described in Water-Supply Paper No. 36, page 165. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 160. During 1900 the following measurements were made by E. W. Myers, R. E. Shuford, and others:

Discharge measurements of French Broad River near Asheville, North Carolina.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 6	2.52	1,368	September 6	3.00	1,002
February 13	7.95	16,967	September 13	2.82	710
March 17	4.20	4,982	September 19	3.24	1,452
April 22	6.80	13,069	October 13	3.00	997
June 6	3.30	2,848	October 23	8.20	16,575
June 15	3.60	2,258	November 20	3.20	1,414
July 4	3.75	4,273	December 14	3.50	1,638
July 6	4.05	3,112	December 30	3.78	2,135
August 11	3.10	1,294			

Daily gage height, in feet, of French Broad River near Asheville, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.67	2.83	7.40	3.40	4.53	3.05	4.05	3.65	3.33	2.95	3.50	3.90
2	2.35	2.65	6.70	3.33	4.47	3.10	4.10	3.55	3.20	2.93	4.00	3.73
3	2.25	2.63	6.10	3.40	3.45	3.03	4.15	3.50	3.15	2.97	4.13	3.64
4	2.30	2.80	5.80	3.73	3.35	3.05	4.20	3.40	3.10	3.10	4.25	4.98
5	2.35	3.10	4.70	3.60	3.27	3.55	4.17	3.35	3.07	3.27	4.13	4.57
6	2.47	3.20	3.75	3.20	3.20	3.80	4.20	3.35	3.10	3.20	4.00	4.35
7	2.90	3.50	3.80	3.15	3.17	4.20	4.05	3.27	3.05	3.10	3.85	4.07
8	2.60	3.60	4.90	3.10	3.15	4.05	4.10	3.23	3.03	3.10	3.58	3.95
9	2.45	3.70	4.70	3.07	3.20	4.00	3.85	3.20	3.10	3.00	3.40	3.70
10	2.33	3.75	4.30	3.05	3.15	3.80	3.65	3.17	3.05	2.95	3.45	3.67
11	2.80	3.00	4.10	3.20	3.10	3.70	3.67	3.15	3.00	2.85	3.47	3.55
12	4.30	3.80	3.80	3.40	3.00	3.40	3.63	3.13	2.85	3.00	3.50	3.50
13	4.25	7.95	3.60	3.30	3.00	3.45	4.80	3.25	2.80	3.13	3.47	3.47
14	3.93	7.05	3.45	3.25	2.90	3.30	4.00	3.30	3.40	3.10	3.38	3.47
15	3.80	6.55	3.37	3.00	2.85	3.20	4.03	3.17	4.65	2.90	3.35	3.49
16	4.45	5.87	3.40	3.95	2.87	7.23	3.80	3.20	5.27	2.80	3.32	3.50
17	4.10	4.95	3.50	4.30	2.85	6.10	3.70	3.35	3.90	2.85	3.30	3.47
18	3.80	4.30	3.70	5.60	2.83	5.70	3.65	3.45	3.80	2.83	3.31	3.45
19	3.60	3.47	3.75	5.75	2.80	4.75	3.63	3.40	3.50	2.80	3.35	3.44
20	4.20	3.40	4.40	5.80	2.77	4.70	3.60	3.30	3.20	2.75	3.37	3.70
21	4.10	3.80	4.20	6.35	2.65	4.67	3.57	3.20	3.15	2.70	3.40	5.11
22	4.00	4.90	4.10	7.40	2.47	4.80	3.55	3.13	3.13	3.80	3.37	4.48
23	3.80	4.70	3.70	5.10	2.30	4.93	3.65	3.15	3.10	8.50	3.33	4.40
24	3.75	4.60	3.60	4.60	2.60	6.60	3.70	3.20	3.05	7.45	3.28	4.35
25	3.65	4.40	3.40	4.55	3.05	5.95	3.75	3.40	3.20	6.20	4.30	4.20
26	3.45	3.50	4.30	4.43	3.10	5.80	3.87	3.35	2.70	4.80	6.45	4.12
27	3.30	3.60	4.00	4.20	3.00	5.70	4.45	3.25	2.75	4.15	5.27	3.85
28	3.20	3.80	3.85	3.90	2.80	4.65	3.85	3.20	2.80	4.00	4.70	3.80
29	2.95	.....	3.80	3.70	2.73	4.10	3.55	3.13	2.90	3.70	4.35	3.80
30	2.90	.....	3.60	3.60	2.67	4.00	3.93	3.20	2.90	3.63	4.05	3.75
31	2.85	.....	3.53	.....	2.80	.....	3.80	3.30	.....	3.60	.....	4.45

FRENCH BROAD RIVER AT OLDTOWN, TENNESSEE.

This is one of the temporary stations established in connection with the general hydrographic study of the southern Appalachian region. Another temporary station was established on Pigeon River, a tributary of the French Broad, and many miscellaneous measurements were made on the French Broad and its tributaries, the results of which are given in Paper No. 49. The Oldtown station on the French Broad was established September 4, 1900, on the highway bridge across the river at that town, which is 2 miles north of Newport, Tennessee. The bridge is a 4-span iron structure, with wooden hand rails. The gage is securely nailed to the second span from the south end of the bridge. The 14-foot mark is the end of the rod, which is butted against the north side of the first strut from the south end of the span, on the downstream side. The outer rim of the pulley is 0.67 foot from the zero of the rod, and the distance between the end of the weight and the pointer on the wire is 25.82 feet. When the gage reads 1 foot, the water level is 20.33 feet below the top surface of the lower chord directly below the zero of the gage rod. The river is straight for a long distance above and below the bridge, and the velocity of the current is well distributed all the way across, though at the low stage at which measurement was made, some places had a velocity too small to give satisfactory results. Almost the entire distance across the bottom seems to be of fine sand. The observer is Jake Odell, Newport, Tennessee. During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

September 4: Gage height, 1 foot; discharge, 867 second-feet.
November 2: Gage height, 1.26 feet; discharge, 1,653 second-feet.
December 15: Gage height, 1.30 feet; discharge, 1,976 second-feet.
December 26: Gage height, —— feet; discharge, 2,901 second-feet.

Daily gage height, in feet, of French Broad River at Oldtown, Tennessee, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	1.20	1.60	17	4.00	.80	1.10	1.30
2	.....	.....	1.20	1.50	18	1.40	.80	1.10	1.20
3	.....	.....	1.50	1.40	19	1.10	.80	1.10	1.20
4	1.00	.....	2.20	1.80	20	1.00	.80	1.10	1.20
5	1.00	.....	1.70	2.80	21	1.00	.80	1.10	2.20
6	.90	.....	1.60	2.20	22	1.00	.80	1.00	2.30
7	.90	.....	1.40	1.80	23	(a)	2.20	1.00	.....
8	.90	.....	1.30	1.60	24	.....	4.00	1.10	.....
9	.80	.....	1.30	1.70	25	.....	3.80	1.20	.....
10	.80	.....	1.20	1.60	26	.....	3.40	4.50	.....
11	.80	.....	1.20	1.50	27	.....	1.80	3.00	.....
12	.80	.....	1.20	1.40	28	.....	1.50	2.20	.....
13	.70	.....	1.20	1.40	29	.....	1.40	1.80	.....
14	1.10	.....	1.10	1.30	30	.....	1.20	1.70	.....
15	1.20	0.80	1.10	1.30	31	.....	1.20	.....	.....
16	2.90	0.80	1.10	1.30					

a No record September 23 to October 14, inclusive.

PIGEON RIVER AT NEWPORT, TENNESSEE.

This station was established September 4, 1900, on the wagon bridge at the upper end of the town of Newport, about 100 yards above the railroad bridge. The course of the river is straight for several hundred yards above and for about 50 yards below the bridge. The current at extreme low water is very sluggish. At even the lowest gage heights the water is very deep. The bottom is smooth, being of rock, in many places overlain with mud. The 15-foot mark of the rod, or the end, is abutted firmly against the east side of the first strut from the west end of the bridge, on the downstream side. The distance between the zero of the rod and the outer rim of the pulley wheel is 0.95 foot, and from the end of the weight to the pointer on the wire the distance is 32.89 feet. When the gage reading is 1 foot, the water level is 27.42 feet below the top surface of the lower chord directly beneath the zero of the gage rod. The rod is of hard pine, well painted and divided into feet and tenths. The drainage area is 655 square miles. The observer is H. M. Boyer, proprietor of a livery stable at Newport. During 1900 the following measurements were made by E. W. Myers and L. V. Branch:

September 4: Gage height, 1.00 foot; discharge, 356 second-feet.
November 2: Gage height, — foot; discharge, 544 second-feet.
December 15: Gage height, 1.28 feet; discharge, 691 second-feet.
December 26: Gage height, 2 feet; discharge, 935 second-feet.

Daily gage height, in feet, of Pigeon River at Newport, Tennessee, for 1900.

Day.	Sept.	Nov.	Dec.	Day.	Sept.	Nov.	Dec.	Day.	Sept.	Nov.	Dec.
1			1.40	12	0.60		1.30	23		1.10	2.40
2			1.50	13	.50		1.20	24		1.10	2.60
3			2.60	14	1.20		1.40	25		1.30	2.10
4			3.20	15	1.60		1.30	26		3.90	2.00
5	0.80		2.30	16	(a)		1.40	27		1.90	2.00
6	.70		2.10	17			1.30	28		1.80	2.00
7	.70		1.90	18			1.30	29		1.50	2.10
8	.60		1.70	19		1.00	1.40	30		1.40	2.50
9	.60		1.50	20		1.00	1.40	31			2.90
10	.50		1.50	21		.90	2.40				
11	.60		1.40	22		1.00	2.00				

a No record September 16 to November 18, inclusive.

TUCKASEGEE RIVER AT BRYSON, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 167. Results of measurements during 1899 will be found in the Twenty-First Annual Report, Part IV, page 162. During 1900 the following measurements were made by E. W. Myers and R. E. Shuford:

Discharge measurements of Tuckasegee River at Bryson, North Carolina.

Date	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
February 9	2.95	3,316	September 8	1.20	598
March 29	2.50	2,321	October 27	1.60	942
April 27	2.65	2,829	November 16	1.20	593
May 24	1.80	1,390	December 12	1.50	998
June 27	2.60	2,673	Do	1.50	903
July 7	2.00	1,472	December 26	1.60	960
August 3	1.60	920			

Daily gage height, in feet, of Tuckasegee River at Bryson, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	2.75	2.60	2.15	2.30	1.50	2.50	1.60	1.40	1.20	1.35	1.50
2	1.50	2.75	2.55	2.15	2.20	1.60	2.40	1.60	1.50	1.20	1.35	1.40
3	1.50	1.60	2.30	2.40	2.30	1.60	2.40	1.50	1.40	1.20	2.10	3.30
4	1.50	1.60	2.60	2.30	2.10	1.70	2.20	1.50	1.30	1.25	1.70	2.50
5	1.50	1.80	2.80	2.25	2.10	2.10	2.20	1.50	1.30	1.25	1.50	2.20
6	1.50	1.65	3.30	2.25	2.10	2.00	2.10	1.50	1.30	1.20	1.50	2.00
7	1.50	1.60	3.50	2.20	2.00	1.90	2.00	1.40	1.20	1.20	1.40	1.80
8	1.60	2.00	3.90	2.15	2.00	1.90	2.00	1.40	1.20	1.20	1.40	1.70
9	1.60	3.10	3.90	2.15	2.30	2.10	2.10	1.40	1.20	1.20	1.30	1.60
10	2.80	2.50	3.85	2.20	2.00	2.00	1.80	1.40	1.20	1.15	1.30	1.60
11	3.10	2.00	3.75	2.40	1.90	1.90	2.00	1.40	1.20	1.15	1.30	1.60
12	2.70	4.00	3.60	2.40	1.80	1.90	1.90	1.40	1.15	1.20	1.30	1.55
13	2.90	8.00	3.50	2.70	1.80	1.90	2.00	1.50	1.15	1.35	1.30	1.50
14	2.80	4.80	2.40	2.30	1.80	1.90	2.00	1.50	1.80	1.20	1.30	1.50
15	2.70	4.20	2.40	2.10	1.70	1.80	2.00	1.40	2.90	1.20	1.30	1.45
16	2.50	4.15	2.35	2.20	1.70	3.00	1.90	1.40	2.10	1.20	1.30	1.40
17	2.50	4.00	3.00	2.20	1.70	3.60	1.90	1.40	1.70	1.15	1.25	1.40
18	2.40	3.85	3.50	3.50	1.70	3.40	1.90	1.25	1.50	1.10	1.20	1.40
19	2.30	3.70	2.65	3.00	1.70	3.00	1.80	1.30	1.40	1.10	1.20	1.40
20	2.30	3.50	3.00	2.80	1.70	2.40	1.80	1.30	1.40	1.10	1.15	1.80
21	2.30	3.40	2.85	3.90	1.60	2.20	2.00	1.30	1.40	1.10	1.35	2.30
22	2.80	3.20	2.60	2.80	1.60	3.40	2.10	1.90	1.35	1.20	1.30	1.70
23	2.80	3.00	6.45	3.30	1.60	3.50	2.00	1.50	1.50	5.20	1.25	2.30
24	2.80	3.00	2.50	2.50	1.85	4.30	1.80	1.50	1.35	2.20	1.20	2.00
25	2.60	3.00	3.00	2.60	1.90	3.00	1.60	1.30	1.30	1.80	3.10	1.80
26	2.50	2.80	2.60	2.70	1.80	2.90	1.60	1.50	1.30	1.60	4.80	1.70
27	2.50	2.80	2.55	2.60	1.60	2.70	2.50	1.50	1.25	1.40	2.10	1.60
28	2.40	2.80	2.40	2.50	1.60	2.50	2.40	1.40	1.25	1.40	1.80	1.70
29	2.40	.....	2.35	2.30	1.60	3.50	2.20	1.40	1.20	1.40	1.70	1.60
30	2.40	.....	2.35	2.50	1.50	3.00	2.00	1.40	1.20	1.40	1.60	1.80
31	2.40	.....	2.20	.....	1.40	.....	1.60	1.50	.....	1.35	.....	2.50

LITTLE TENNESSEE RIVER AT JUDSON, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 168. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 163. During 1900 the following measurements were made by E. W. Myers and R. A. Shuford:

February 10: Gage height, 4.55 feet; discharge, 3,726 second-feet.
March 30: Gage height, 4.40 feet; discharge, 3,179 second-feet.
April 28: Gage height, 4.55 feet; discharge, 3,785 second-feet.
May 25: Gage height, 3.50 feet; discharge, 1,744 second-feet.
June 28: Gage height, 5 feet; discharge, 4,644 second-feet.
August 4: Gage height, 3.45 feet; discharge, 1,668 second-feet.
November 17: Gage height, 2.88 feet; discharge, 1,008 second-feet.
December 27: Gage height, 3.40 feet; discharge, 1,414 second-feet.

Daily gage height, in feet, of Little Tennessee River at Judson, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.36	2.65	6.33	3.68	2.93	3.40	5.68	3.71	3.19	3.21	3.00	3.31
2	2.36	2.70	4.42	3.67	2.93	4.00	5.69	3.61	3.18	3.22	3.00	3.29
3	2.38	2.68	3.78	3.67	2.84	3.52	5.69	3.51	3.10	3.22	3.50	3.28
4	2.32	2.67	3.70	3.41	2.71	3.76	5.66	3.41	3.10	3.22	3.41	6.07
5	2.32	2.67	3.70	3.33	2.70	3.52	4.38	3.41	3.11	3.21	3.10	5.63
6	2.30	2.69	3.84	3.30	2.70	3.62	4.32	3.41	3.13	3.20	3.00	4.28
7	2.31	3.72	3.84	2.91	2.68	3.72	4.32	3.31	3.12	3.21	3.00	4.22
8	2.31	3.40	3.93	2.88	2.69	4.00	4.61	3.31	3.13	3.22	2.91	3.10
9	2.33	3.78	6.40	2.80	2.68	3.82	4.60	3.21	3.11	3.22	2.91	3.14
10	2.34	4.37	4.30	2.74	2.68	3.62	4.74	3.21	3.11	3.23	2.91	3.14
11	2.34	3.39	4.40	2.79	2.67	3.52	3.61	3.21	3.14	2.51	2.91	3.14
12	2.42	3.33	4.58	5.45	2.53	3.62	3.71	3.21	3.13	2.61	2.91	3.15
13	4.38	11.35	4.58	5.92	2.58	4.62	3.71	3.21	3.14	2.81	2.81	3.25
14	3.72	5.68	3.98	4.39	2.59	4.00	3.91	3.11	3.15	2.71	2.81	3.25
15	2.91	4.58	3.93	3.58	2.71	3.82	4.38	3.21	3.16	2.61	2.81	3.19
16	2.90	3.33	4.38	3.92	2.70	3.92	4.32	3.11	3.16	2.61	2.81	3.23
17	2.90	3.41	4.40	3.00	2.68	3.88	3.81	3.11	3.19	2.61	2.81	3.24
18	2.83	3.48	3.99	3.54	2.67	3.89	3.71	3.21	3.20	2.61	2.81	3.21
19	2.82	3.48	3.98	3.50	2.64	3.84	3.51	3.22	3.20	2.51	2.81	3.21
20	2.81	3.52	3.98	4.38	2.81	4.48	3.51	3.28	3.21	2.51	2.81	3.92
21	2.82	3.58	3.90	3.49	2.90	4.67	3.41	3.28	3.22	2.59	3.00	5.68
22	2.85	3.58	3.90	3.48	2.90	4.93	3.51	3.29	3.21	2.61	3.00	4.91
23	2.87	3.62	3.94	3.48	3.35	5.41	3.71	3.28	3.20	3.61	2.81	3.72
24	2.72	3.69	3.93	3.40	4.50	5.40	3.71	3.27	3.22	6.71	2.81	3.69
25	2.75	3.63	3.90	3.40	4.48	5.40	3.41	3.27	3.22	5.21	3.61	3.68
26	2.78	3.60	3.90	3.32	4.47	5.91	3.71	3.22	3.21	3.71	4.81	3.65
27	2.78	3.90	3.82	3.33	4.43	5.90	3.61	3.20	3.23	3.51	4.00	3.65
28	2.73	3.80	3.80	3.29	3.30	5.88	4.31	3.21	3.20	2.51	3.01	3.65
29	2.72	.....	3.84	3.28	3.40	5.83	4.00	3.21	3.21	3.31	3.51	3.92
30	2.69	.....	3.84	3.28	3.40	5.71	3.91	3.23	3.22	3.30	3.51	3.48
31	2.69	.....	3.71	.....	3.40	.....	3.71	3.23	.....	3.30	.....	3.43

HIWASSEE RIVER AT MURPHY, NORTH CAROLINA.

This station is described in Water-Supply Paper No. 36, page 169. The observer is William Mingus, of Murphy. Records of measurements during 1899 will be found in the Twenty-first Annual Report, Part IV, page 165. During 1900 the following measurements were made by E. W. Myers and R. E. Shuford:

Discharge measurements of Hiwassee River at Murphy, North Carolina.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
February 11	6.10	1,534	September 9	5.05	345
February 14	7.95	4,567	November 18	5.20	443
April 29	6.10	1,466	December 13	5.53	762
May 26	5.52	755	December 13	5.45	698
June 29	7.10	3,405	December 28	5.70	865
July 8	5.90	1,155			

Daily gage height, in feet, of Hiwassee River at Murphy, North Carolina, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	5.12	7.00	5.90	6.10	5.40	6.80	5.80	5.35	5.00	5.20	5.40
2	5.20	5.30	6.50	5.90	6.00	5.40	6.60	5.40	5.20	4.90	5.25	5.45
3	5.51	5.35	6.25	5.90	6.00	5.60	7.00	5.40	5.15	5.00	6.20	5.40
4	5.30	5.40	6.10	6.70	5.90	5.80	6.40	5.40	5.10	5.10	5.60	7.20
5	5.30	5.60	6.00	6.10	5.90	5.50	6.20	5.30	5.20	5.10	5.40	6.40
6	5.20	5.40	6.00	6.05	5.80	6.10	6.00	5.30	5.15	5.05	5.35	6.00
7	5.20	5.40	7.00	6.00	5.70	6.00	5.90	5.30	5.10	5.00	5.35	5.80
8	5.20	5.40	7.50	5.90	5.70	6.10	5.80	5.20	5.05	5.30	5.30	5.75
9	5.20	6.72	7.40	5.85	5.70	6.10	6.20	5.20	5.05	5.10	5.25	5.60
10	5.20	6.02	6.90	5.80	5.70	6.30	5.70	5.20	5.00	5.05	5.25	5.60
11	5.30	6.10	6.60	6.10	5.70	6.10	5.70	5.20	5.00	5.00	5.20	5.50
12	6.30	6.10	6.40	6.30	5.65	6.10	5.80	5.20	5.00	4.90	5.25	5.50
13	5.80	12.60	6.30	6.10	5.60	6.60	5.80	5.20	5.00	5.30	5.20	5.45
14	5.60	7.70	6.12	6.00	5.60	6.10	5.70	5.20	5.05	5.10	5.25	5.45
15	5.60	7.15	6.05	6.00	5.60	5.80	5.60	5.20	7.00	5.00	5.20	5.40
16	5.50	6.50	6.30	5.90	5.50	5.80	5.60	5.10	6.45	5.00	5.15	5.40
17	5.40	6.20	6.00	5.80	5.40	6.20	5.60	5.30	5.70	4.90	5.20	5.40
18	5.45	5.90	6.00	6.20	5.50	6.00	5.60	5.20	5.45	4.80	5.15	5.30
19	5.90	5.90	6.85	6.70	5.70	6.30	5.50	5.10	5.35	5.00	5.20	5.30
20	6.60	5.80	7.40	6.40	5.50	6.10	5.50	5.10	5.35	4.90	5.15	5.80
21	6.20	6.00	6.90	7.10	5.40	5.90	5.50	5.10	5.25	4.90	5.20	6.70
22	5.90	6.40	6.60	6.80	5.40	5.80	5.60	5.10	5.00	5.00	5.30	5.90
23	5.80	6.15	6.40	6.70	5.40	6.30	5.70	5.30	5.40	4.90	5.20	5.80
24	5.65	6.00	6.35	6.50	5.60	6.60	5.60	5.90	5.20	7.10	5.15	6.00
25	5.60	6.00	6.40	6.55	5.50	6.50	5.40	5.30	5.20	6.00	5.30	5.80
26	5.60	6.00	6.40	6.55	5.60	7.00	5.50	5.40	5.20	5.70	6.70	5.70
27	5.50	5.90	6.30	6.30	5.50	7.20	5.70	5.20	5.15	5.60	6.00	5.65
28	5.40	5.85	6.30	6.20	5.50	7.10	5.90	5.15	5.15	5.40	5.70	5.60
29	5.40	.....	6.05	6.20	5.40	7.00	5.70	5.15	5.10	5.30	5.60	5.70
30	5.40	.....	6.10	6.10	5.40	6.80	5.80	5.15	5.05	5.20	5.50	.....
31	5.50	.....	6.00	.....	5.40	.....	5.60	5.15	.....	5.25	.....	.....

HIWASSEE RIVER AT RELIANCE, TENNESSEE.

This station was established by O. P. Hall on August 17, 1900. The gage is a vertical timber, graduated to feet and tenths, spiked to a tree on the right bank of the river about 200 feet above the Atlanta, Knoxville and Northern Railroad bridge, and very near the ferry landing. Measurements are made from the railroad bridge, a new steel structure of three spans of 140 feet each, which has recently been substituted for the old wooden bridge. Bench mark No. 1 is a nail in a hickory tree on the right bank of the river, about 100 feet above the end of the bridge and 8.56 feet above the zero of the gage. Bench mark No. 2 is the base of rail 40 feet from the right-bank end of bridge, and is 24.70 feet above the zero of the gage. At ordinary stages the river is about 350 feet wide at this point, and the section is a fairly good one, but at low stages the current becomes very sluggish. The observer is C. V. Higdon, a ferryman who lives near the gage. During 1900 the following measurements were made by O. P. Hall:

August 17: Gage height, 1.12 feet; discharge, 1,123 second-feet.
September 3: Gage height, 1.16 feet; discharge, 1,159 second-feet.
November 30: Gage height, 1.72 feet; discharge, 1,985 second-feet.
December 19: Gage height, 1.42 feet; discharge, 1,442 second-feet.

Daily gage height, in feet, of Hiwassee River at Reliance, Tennessee, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.40	1.05	1.30	1.60	17	.....	2.00	1.00	1.20	1.50
2	.....	1.30	1.00	1.20	1.50	18	.....	1.60	1.00	1.10	1.50
3	.....	1.20	1.00	1.80	1.50	19	1.10	1.40	.90	1.10	1.40
4	.....	1.05	1.00	1.30	2.80	20	1.05	1.30	.90	1.20	1.50
5	.....	1.00	1.00	1.40	3.00	21	1.05	1.20	1.90	1.30	2.80
6	.....	1.10	1.00	1.50	2.40	22	1.05	1.20	1.00	1.40	2.80
7	.....	1.05	1.00	1.40	2.00	23	1.10	1.30	1.30	1.30	2.10
8	.....	1.00	1.30	1.40	2.00	24	1.50	1.30	4.00	1.50	2.40
9	.....	1.00	1.50	1.30	1.90	25	1.40	1.20	2.00	1.70	2.30
10	.....	.90	1.20	1.30	1.80	26	1.30	1.10	1.50	4.50	2.00
11	.....	.90	1.10	1.40	1.70	27	1.30	1.10	1.60	3.60	1.90
12	.....	.90	1.10	1.30	1.60	28	1.15	1.05	1.50	2.00	1.90
13	.....	.90	1.20	1.30	1.60	29	1.10	1.05	1.50	1.80	2.00
14	.....	1.00	1.40	1.30	1.60	30	1.10	1.05	1.40	1.70	1.90
15	.....	3.60	1.10	1.20	1.50	31	1.10	.....	1.30	.....	2.40
16	.....	3.50	1.00	1.20	1.50						

HIWASSEE RIVER AT CHARLESTON, TENNESSEE.

This station was originally established by the United States Engineer Corps, but is now maintained as a half-year station by the United States Weather Bureau. It is described in Water-Supply Paper No. 36, pages 170 and 171, where will also be found the records of measurements made during 1899. During 1900 the following measurements were made by Max Hall:

March 14: Gage height, 3.50 feet; discharge, 6,044 second-feet.
April 25: Gage height, 4 feet; discharge, 7,078 second-feet.
December 8: Gage height, 2.65 feet; discharge, 4,729 second-feet.

Daily gage height, in feet, of Hiwassee River at Charleston, Tennessee, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.2	3.7	3.1	3.1	1.5	5.8	2.0	1.2	0.7	1.2	2.1
2	1.0	1.0	5.8	2.9	2.9	1.6	4.7	1.8	1.6	.7	1.2	1.9
3	.9	1.2	4.5	2.9	3.0	2.0	5.0	1.6	1.2	.7	1.7	1.8
4	.6	1.6	3.7	4.6	2.9	2.2	4.9	1.5	1.0	.7	3.9	2.5
5	.9	1.8	3.2	6.0	2.6	2.2	3.5	1.4	.9	.7	2.4	6.7
6	1.2	2.3	2.9	4.0	2.5	2.1	3.0	1.4	.9	.7	1.8	4.3
7	1.1	1.7	4.5	3.4	2.4	3.3	2.7	1.3	.9	.8	1.6	3.1
8	1.1	1.6	9.0	3.2	2.3	4.4	2.5	1.3	.8	1.2	1.4	2.8
9	1.1	2.9	11.5	3.0	2.3	3.5	2.5	1.2	.7	2.0	1.4	2.6
10	1.1	4.9	8.0	2.9	2.5	3.0	2.3	1.2	.7	1.3	1.3	2.3
11	1.4	3.2	6.0	3.0	2.3	3.1	2.2	1.1	.7	1.0	1.2	2.1
12	4.6	3.1	4.8	4.9	2.1	3.4	2.0	1.1	.6	1.1	1.2	2.0
13	5.0	14.2	4.0	4.6	2.0	3.7	2.2	1.1	.6	1.7	1.1	1.9
14	3.0	18.6	3.7	3.7	2.0	4.7	2.2	1.2	.6	1.4	1.1	1.8
15	2.4	9.2	3.4	3.3	1.9	3.2	2.1	1.2	3.0	1.2	1.1	1.8
16	2.0	6.2	3.9	3.0	1.9	2.8	1.9	1.1	6.6	1.0	1.1	1.7
17	1.8	4.7	4.1	3.7	1.8	4.0	1.8	1.0	3.3	.9	1.0	1.6
18	1.7	3.6	3.4	5.1	1.7	4.6	1.7	1.0	2.0	.8	1.0	1.6
19	2.4	3.0	3.3	5.2	1.9	3.6	1.7	1.1	1.5	.7	1.0	1.5
20	6.4	2.8	7.5	5.0	2.1	3.6	1.6	1.0	1.3	.7	1.1	1.5
21	5.4	2.7	9.0	5.4	1.8	2.7	1.6	.9	1.2	.7	1.2	3.1
22	3.7	5.1	6.0	6.4	1.7	2.3	1.6	.8	1.1	.7	1.3	3.8
23	2.9	5.0	5.0	5.3	1.6	2.6	1.8	1.0	1.2	1.3	1.4	2.8
24	2.5	3.7	4.5	4.6	1.7	4.2	2.3	1.2	1.3	9.0	1.2	4.1
25	2.3	4.2	4.0	4.3	2.0	4.8	1.8	2.4	1.1	3.8	1.3	3.6
26	2.1	3.8	6.0	4.0	2.0	5.0	1.6	1.5	1.0	2.3	10.0	2.9
27	1.9	3.3	5.2	3.9	2.1	5.3	2.7	1.4	.9	1.8	7.0	2.6
28	1.8	12.9	4.4	3.7	1.7	5.9	3.8	1.5	.9	1.7	4.0	2.4
29	1.7	.....	3.9	3.5	1.6	5.7	3.7	1.2	.9	1.5	2.9	2.6
30	1.5	.....	3.6	3.3	1.5	8.0	2.7	1.2	.8	1.4	2.3	2.6
31	1.4	.....	3.3	.....	1.5	.....	2.4	1.0	.....	1.3	.....	3.9

TOCCOA RIVER NEAR BLUERIDGE, GEORGIA.

This station, which was established by B. M. Hall November 25, 1898, is at the Morganton bridge, about 4 miles east of the town of Blueridge. It is described in Water-Supply Paper No. 36, page 171. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 166. During 1900 the following measurements were made by B. M. Hall and his assistants.

March 23: Gage height, 3.36 feet; discharge, 967 second-feet.
May 18: Gage height, 2.90 feet; discharge, 679 second-feet.
November 28: Gage height, 2.95 feet; discharge, 626 second-feet.
July 19: Gage height, 2.90 feet; discharge, 680 second-feet.
December 17: Gage height, 2.65 feet; discharge, 419 second-feet.

Daily gage height, in feet, of Toccoa River near Blueridge, Georgia, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.1	3.6		4.3	3.6	2.6	2.5	3.4	2.6
2		3.1	3.5		4.3	3.5	2.6	2.5	3.4	3.0
3		3.1	3.5		4.2	3.4	2.6	2.5	3.4	3.6
4		3.0	3.4		4.2	3.4	2.6	2.6	3.4	3.6
5		3.0	3.5		4.1	3.4	2.6	2.6	3.4	3.5
6		3.0	3.5		3.6	3.4	2.6	2.6	3.3	3.5
7		3.0	3.4		3.6	3.4	2.6	2.6	3.3	3.4
8		3.0	3.4		3.5	3.4	2.6	2.6	3.3	3.4
9		3.0	3.4		3.5	3.3	2.6	2.6	3.2	3.3
10		3.0	3.3		3.5	3.3	2.6	2.8	3.2	3.3
11		3.4	3.1		3.4	3.3	2.6	2.8	3.1	3.2
12		3.2	3.0		3.4	3.2	2.6	2.9	3.1	3.2
13		3.0	3.0		3.4	3.2	3.0	2.9	3.1	3.0
14		3.0	3.0		3.3	3.2	3.4	2.8	3.1	3.0
15		3.0	3.0		3.3	3.1	4.0	2.8	3.1	2.8
16		3.0	2.8		3.3	2.8	3.6	2.6	3.0	2.8
17		3.3	2.8		3.3	2.8	3.4	2.6	3.0	2.8
18		3.5	2.6		3.2	2.8	3.4	2.6	3.0	2.8
19		3.5	3.6		3.2	2.8	3.2	2.6	3.0	2.8
20		3.4	(a)		3.2	2.8	3.2	2.6	3.0	2.7
21		3.3			3.1	2.8	3.0	2.6	3.0	2.7
22		3.3			3.1	3.0	3.0	2.9	2.8	2.6
23	3.4	3.3			3.6	3.0	2.8	8.6	2.7	2.6
24	3.5	3.2			3.5	3.0	2.8	6.0	2.7	2.6
25	3.6	3.5			3.5	2.8	2.6	5.4	2.7	2.6
26	3.5	3.5			3.5	2.8	2.5	4.0	2.7	2.6
27	3.5	3.6		5.0	4.0	2.8	2.5	3.6	2.6	3.0
28	3.4	3.5		5.0	4.0	2.7	2.5	3.6	2.6	3.0
29	3.3	3.4		4.5	3.8	2.7	2.5	3.6	2.6	3.0
30	3.2	3.6		4.3	3.8	2.7	2.5	3.5	2.6	2.8
31	3.2				3.6	2.6		3.4		2.8

a No record May 20 to June 26, inclusive.

TENNESSEE RIVER AT KNOXVILLE, TENNESSEE.

This station was originally established by the United States Weather Bureau at the old county highway bridge, which has been torn down and replaced by a new bridge. Instead of placing the gage at the new bridge, it was decided to move it down the river, in order to get below some shoals and wing dams which have been put in for boating. A temporary gage was put in at the Knoxville and Augusta Railroad bridge, a half mile below the highway bridge, and was used during the greater part of the year 1899. In the latter part of that year a new permanent gage was established, and readings from it began November 1, 1899. The new gage is located on the right bank

of the river, just below the mouth of the West Knoxville Bayou and about 1,000 feet below the temporary gage at the Knoxville and Augusta Railroad bridge. The gage, which is graduated to feet and tenths, is in two sections; the first, a sloping section made of a 2-inch by 4-inch pine timber spiked on top of an 8-inch by 8-inch oak sill well bolted to piles and embedded in crushed stone, reading from —2 feet to 12 feet; the second, a vertical section of standard Weather Bureau pattern, brass scale, screwed to one of the bents of the railroad trestle across the West Knoxville Bayou, about 50 feet from the bank of the river and from the sloping gage, reading from 12 feet to 36.5 feet. The gage is fastened to the upstream post of the bent facing away from the river. The zero of the gage is 804.3 feet above sea level. The bench mark is a cross in the stone on the east corner of the base to the right-bank pier of the Knoxville and Augusta Railroad bridge, and is 806.7 feet above sea level and 2.4 feet above the zero of the gage. The gage was located for the United States Weather Bureau by the United States Engineer Corps. Daily records are kept by the United States Weather Bureau and are furnished to the Geological Survey. Measurements are made at the Cherokee highway bridge 2 miles below the new gage. This bridge is a three-span iron structure and is about 80 feet above low water. The width of the river at low water is 550 feet. The section is a good one, but the current is rather sluggish at low water. During 1900 the following measurements were made by Max Hall:

April 25: Gage height, 4.35 feet; discharge, 17,219 second-feet.
December 7: Gage height, 5.50 feet; discharge, 23,529 second-feet.

Daily gage height, in feet, of Tennessee River at Knoxville, Tennessee, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.7	0.8	3.9	4.2	2.7	1.2	3.8	2.7	1.2	0.6	1.1	3.0
2	.5	.7	8.4	3.9	2.6	1.1	2.9	2.2	1.2	.4	1.0	2.5
3	.4	.8	11.1	3.5	2.4	1.1	2.8	1.4	1.0	.4	1.1	2.2
4	.2	1.0	9.1	3.4	2.4	1.1	2.8	1.2	.7	.3	1.5	2.6
5	.8	1.3	6.1	4.5	2.4	1.5	2.7	1.2	.5	.2	3.6	4.1
6	.8	1.6	5.0	4.1	2.3	2.4	2.5	1.1	.4	.2	3.5	6.6
7	.9	1.9	4.0	3.5	2.2	2.5	2.0	1.0	.3	.7	2.5	5.9
8	.9	1.7	4.9	3.2	2.1	1.9	2.0	.8	.4	.8	2.1	5.2
9	1.0	3.0	9.5	3.0	2.0	2.2	1.7	.8	.3	.7	1.8	3.5
10	.9	4.1	10.1	2.8	2.0	2.2	1.6	.7	.2	.7	1.5	3.0
11	1.1	4.2	7.9	2.7	2.1	1.9	1.4	.6	.2	.5	1.3	2.7
12	2.4	3.7	6.4	2.7	2.1	1.8	1.3	.5	.1	.4	1.2	2.3
13	4.6	6.9	5.5	2.8	2.1	1.7	1.2	.9	.0	.3	1.1	2.0
14	4.7	12.4	4.7	2.9	1.9	2.0	1.3	.6	.3	.2	1.0	1.9
15	4.3	12.7	4.2	2.7	1.8	2.0	1.4	.8	.6	.2	1.0	1.8
16	2.9	8.9	4.0	2.5	1.7	2.2	1.3	1.4	1.1	.3	.9	1.7
17	2.2	7.4	4.6	2.3	1.6	4.0	1.3	1.0	3.3	.2	.8	1.6
18	2.0	5.6	4.6	2.2	1.5	7.8	1.2	.8	3.6	.2	.8	1.4
19	2.0	4.0	4.5	3.2	1.4	6.5	1.1	.7	2.2	.2	.8	1.3
20	2.6	3.3	6.0	4.7	1.4	5.1	1.0	.6	1.4	.1	.7	1.3
21	3.1	2.9	11.9	4.6	1.4	4.3	.9	.5	1.0	.1	.8	1.3
22	3.1	3.0	13.2	5.7	1.4	3.3	1.3	.4	1.0	.1	.8	1.8
23	2.9	3.2	9.4	6.4	1.4	2.7	1.2	.4	1.0	.0	.8	2.5
24	2.5	5.0	6.7	5.5	1.3	3.3	1.5	1.4	1.0	4.9	.8	2.5
25	2.0	5.0	5.5	4.7	1.8	3.6	1.5	1.5	1.0	9.4	.8	2.3
26	2.1	4.9	5.7	4.0	1.8	4.4	1.7	1.2	1.0	5.8	5.6	2.2
27	1.8	4.8	6.9	3.8	2.0	4.2	5.6	1.1	1.0	4.6	9.6	2.0
28	1.7	3.7	6.7	3.6	1.8	3.7	6.0	.9	.9	3.4	9.1	1.9
29	1.5	.....	5.8	3.2	1.5	3.4	4.8	.9	.8	1.8	5.0	1.7
30	1.4	.....	5.0	2.9	1.3	5.8	4.0	.7	.7	1.4	3.6	1.7
31	1.1	.....	4.5	.....	1.2	.....	3.5	.9	.....	1.3	.....	1.8

TENNESSEE RIVER AT CHATTANOOGA, TENNESSEE.

This station was established in 1879, at the foot of Lookout street, just below Chattanooga Island, by the Signal Corps of the United States Army; but since July 1, 1891, it has been in charge of the Weather Bureau. During the year 1900 a new gage was established. It is a vertical timber bolted to the south side of the third stone pier from the south end of the bridge. Gage heights are obtained from L. M. Prindell, United States Weather Bureau observer. Records of measurements made during 1899 will be found in the Twenty-first Annual Report, Part IV, page 168. During 1900 the following measurements were made by Max Hall and others:

March 13: Gage height, 11.25 feet; discharge, 66,012 second-feet.
July 27: Gage height, 3.45 feet; discharge, 18,470 second-feet.

Daily gage height, in feet, of Tennessee River at Chattanooga, Tennessee, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	3.25	8.05	7.85	6.20	2.85	8.85	6.20	2.10	2.00	2.90	8.70
2	(a)	2.95	8.70	7.20	5.65	2.80	8.15	5.40	2.00	1.80	2.60	6.50
3	(a)	2.60	10.90	6.85	5.35	3.00	6.95	4.70	2.30	1.70	2.50	5.60
4	(a)	2.50	12.50	7.25	5.15	3.20	6.30	4.20	2.50	1.50	2.90	5.10
5	(a)	2.90	12.75	8.05	4.95	3.20	5.80	3.30	2.30	1.40	3.30	5.60
6	2.10	3.50	10.65	8.55	4.80	3.50	5.40	3.20	2.00	1.30	3.70	6.90
7	2.20	3.95	10.00	7.85	4.65	5.65	5.00	2.90	1.70	1.30	4.20	8.30
8	2.30	3.90	11.65	7.05	4.45	6.65	4.50	2.60	1.60	1.60	4.20	9.20
9	2.35	5.35	14.55	6.50	4.45	6.15	4.20	2.40	1.40	1.80	3.70	8.50
10	2.45	8.40	16.50	6.10	4.35	5.30	4.20	2.30	1.30	2.10	3.20	7.00
11	3.35	9.40	16.15	6.50	4.30	5.00	4.30	2.10	1.20	2.10	3.00	6.10
12	6.05	8.95	14.25	7.50	4.30	4.90	3.80	2.00	1.10	2.50	2.70	5.40
13	8.15	13.90	11.65	7.40	4.15	4.50	3.40	1.90	1.00	3.00	2.50	4.90
14	8.70	21.55	9.85	7.00	4.00	5.20	3.30	1.90	1.10	2.50	2.30	4.50
15	8.45	24.00	8.65	6.50	3.85	5.30	3.30	2.10	1.80	1.90	2.20	4.30
16	7.80	21.40	8.00	6.30	3.75	5.25	3.30	2.20	3.10	1.80	2.10	4.20
17	6.35	17.00	7.80	8.75	3.60	5.45	3.20	2.30	4.00	1.60	2.00	4.00
18	5.50	12.05	7.55	10.65	3.50	6.15	3.10	2.30	4.10	1.50	2.00	3.60
19	5.80	9.25	7.55	9.75	3.40	8.85	3.00	2.30	4.60	1.40	1.90	3.40
20	8.50	7.70	8.55	9.40	3.40	9.20	2.90	2.20	4.70	1.30	1.90	3.30
21	9.40	7.10	11.60	11.70	3.25	8.90	2.70	1.90	3.90	1.20	2.10	3.30
22	8.85	7.70	14.95	12.00	3.15	7.65	2.50	1.80	3.00	1.20	2.20	4.00
23	7.95	8.50	17.40	11.35	3.05	6.40	2.50	1.70	2.60	1.40	2.30	4.20
24	7.20	8.55	16.45	10.70	3.00	6.25	2.80	1.80	2.40	2.20	2.80	4.70
25	6.15	8.55	12.65	9.75	3.15	7.15	3.00	1.90	2.70	4.10	3.20	5.20
26	5.50	9.50	11.15	8.50	3.20	7.60	3.10	2.50	2.70	7.00	7.80	5.40
27	5.00	9.30	10.90	7.80	3.35	8.05	3.30	3.10	2.60	7.50	13.90	5.20
28	4.65	8.45	10.70	7.45	3.60	8.20	4.60	2.70	2.40	6.00	15.60	4.60
29	4.20	.....	10.20	7.05	3.60	8.60	8.00	2.50	2.30	4.90	15.60	4.30
30	3.90	.....	9.35	6.60	3.35	8.70	8.20	2.30	2.20	3.70	13.20	4.20
31	3.55	.....	8.50	.....	3.05	.....	7.30	2.20	.....	3.40	.....	4.50

a Frozen.

[Continued in Water-Supply Paper No. 49, where will be found numerous miscellaneous measurements of streams in the southern Appalachian region.]

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DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 49

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1900

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART III

WASHINGTON

GOVERNMENT PRINTING OFFICE

1901

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OPERATIONS AT RIVER STATIONS, 1900.

PART III.

MEASUREMENTS AT RIVER STATIONS.[1]

MISCELLANEOUS MEASUREMENTS OF STREAMS IN SOUTHERN APPALACHIAN REGION.

A hydrographic investigation of the southern Appalachian region was made during the field season of 1900. A detailed report of the work will appear in a later publication. During the progress of the investigation a large number of measurements were made of various streams, as shown in the following tables. The tables are arranged in geographic order, commencing with the more northerly streams, which drain into the Atlantic Ocean, and ending with those which belong to the Gulf drainage.

Miscellaneous discharge measurements of Yadkin River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 21	Yadkin River	Wilkesboro, N. C.	N. C. Curtis	26.73	780.0
June 23	do	do	do	26.14	1,737.0
July 4	do	do	do	26.83	663.0
July 12	do	do	do	27.05	488.2
Aug. 6	do	do	do	27.20	386.0
Oct. 1	do	do	do	27.20	369.1
Nov. 4	do	do	do	26.22	1,331.0
June 20	do	Second ford below Patterson's mill, North Carolina.	do	13.3	182.0
July 14	do	do	do	13.5	100.3
Aug. 7	do	do	do	13.4	76.2
Sept. 26	do	do	do	13.53	43.0
June 20	Elk Creek	One-fourth mile above ford, N. C.	do	2.4	119.0
July 13	do	do	do	2.43	61.0
Aug. 6	do	do	do	2.60	37.0
Sept. 26	do	do	do	2.61	30.0
June 21	Stony Creek	Footbridge at Colberts, North Carolina.	do	2.65	78.4
July 13	do	do	do	2.70	80.5
Aug. 6	do	do	do		50.0
Sept. 26	do	do	do	2.87	31.10
June 21	Louis Fork of Yadkin River.	Footbridge on Mount Pleasant road, North Carolina.	do	3.10	127.0
July 13	do	do	do	3.23	99.0
Aug. 6	do	do	do	3.30	69.0
Sept. 26	do	do	do	3.33	63.0

[1] Continued from Water-Supply Paper No. 48.

Miscellaneous discharge measurements of Yadkin River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 23	Reddie River	North Wilkesboro, N. C	N. C. Curtis	24.73	218.1
July 12	do	do	do	25.15	98.1
Aug. 4	do	do	do		93.0
Oct. 1	do	do	do	25.25	60.2
June 23	Mulberry River	Trestle of Greensboro and Wilkesboro division of Southern R. R., North Carolina.	do	21.93	108.4
July 3	do	do	do	22.25	50.3
Aug. 4	do	do	do	22.50	39.25
Sept. 27	do	do	do	22.42	61.2
Nov. 2	do	do	do		55.0
June 25	Roaring River	Greensboro and Wilkesboro R. R. bridge, North Carolina.	do	23.68	520.2
July 9	do	do	do	25.45	161.4
Aug. 4	do	do	do	25.75	117.0
Sept. 27	do	do	do	25.13	109.0
Nov. 2	do	do	do	24.27	197.0
Sept. 27	Big Bugaboo Creek	Ford of road from Roaring River to Elkin, N. C.	do	1.28	30.0
June 25	Big Elkin River	Greensboro and Wilkesboro R. R. bridge, North Carolina.	do	24.53	65.0
July 9	do	do	do	25.95	29.0
Aug. 4	do	do	do		24.0
Sept. 27	do	do	do	26.22	27.0
June 26	Mitchell River	do	do	21.63	393.1
July 10	do	do	do	24.00	139.2
Aug. 3	do	do	do	24.25	119.0
Sept. 28	do	do	do	24.25	160.0
Nov. 1	do	do	do	23.89	216.0
June 26	Fisher River	Greensboro and Wilkesboro R. R. trestle, North Carolina.	do	20.93	549.0
July 10	do	do	do	23.38	172.0
Aug. 3	do	do	do	23.60	126.0
Sept. 28	do	do	do	23.72	119.0
Nov. 1	do	do	do	23.70	235.0
June 27	Ararat River	do	do	23.9	801.0
July 11	do	do	do	26.0	317.1
Aug. 2	do	do	do	26.25	265.44
Sept 29	do	do	do	26.46	243.0
Oct. 31	do	do	do	25.66	307.0

Miscellaneous discharge measurements of Catawba River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 28	Catawba River	Oldfort, N. C	H. A. Pressey	10.10	53.0
Aug. 20	do	do	N. C. Curtis	12.70	11.0
Sept. 20	do	do	do	12.78	12.0
June 28	Mill Creek	do	H. A. Pressey	3.85	85.0
Aug. 20	do	do	N. C. Curtis	6.73	27.0
Sept. 20	do	do	do		13.0
June 28	Jarrett Creek	Near Oldfort, N. C	H. A. Pressey		17.0
Do	Curtis Creek	Two hundred feet above ford of Oldfort road, North Carolina.	do		82.11
Aug. 20	do	do	N. C. Curtis		16.50
June 28	Crib Creek	Near ford of main road, North Carolina.	H. A. Pressey	4.9	28.03
Aug. 28	do	do	N. C. Curtis		10.0
June 28	Clear Creek	Two hundred feet above ford of main road, North Carolina.	H. A. Pressey		25.25
Aug. 28	do	do	N. C. Curtis		12.0
June 14	Buck Creek	One-eighth mile above mouth at main ford, North Carolina.	H. A. Pressey		51.91
Aug. 20	do	do	N. C. Curtis	5.35	41.4
July 3	North Fork of Catawba River.	First ford above mouth, North Carolina.	H. A. Pressey		240.2
Aug. 18	do	do	N. C. Curtis		67.3
Sept. 21	do	do	do	3.18	61.69

Miscellaneous discharge measurements of Catawba River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 15	Turkey Cove Creek	Just above second ford, North Carolina.	L. V. Branch	5.75	21.48
June 26	do	do	do	5.30	164.8
June 14	Muddy Creek	Bridgewater, N. C	H. A. Pressey	5.80	161.9
June 16	do	do	L. V. Branch	4.1	618.0
July 10	do	do	do	6.0	119.2
Aug. 17	do	do	N. C. Curtis	6.43	98.6
Sept. 21	do	do	do	6.34	101.7
June 14	Paddy Creek	Near Bridgewater, N. C	H. A. Pressey	11.3	19.78
June 16	do	do	L. V. Branch	5.4	203.67
July 10	do	do	do	11.55	11.5
Aug. 17	do	do	N. C. Curtis	12.35	7.0
June 21	Linville River	Linville, N. C	H. A. Pressey	14.83	21.0
June 24	do	do	do	14.23	90.22
June 14	Cane Creek	Lowest ford of main Morganton road, North Carolina.	do	5.72	18.58
June 18	do	do	L. V. Branch	5.85	28.45
Aug. 17	do	do	N. C. Curtis	6.3	7.2
June 14	Silver Creek	Near Morganton, N. C	L. V. Branch	6.84	124.0
Aug. 10	do	do	N. C. Curtis	8.30	48.4
Sept. 24	do	do	do	8.20	56.0
June 13	Upper Creek	One-fourth mile above mouth, North Carolina.	E. W. Myers	2.2	182.4
July 6	do	do	L. V. Branch	2.3	50.0
Aug. 8	do	do	N. C. Curtis		85.05
Sept. 24	do	do	do		60.0
June 20	do	Ford at Henderson's mill, North Carolina.	H. A. Pressey	12.9	20.42
Do	do	Upper Creek Falls, North Carolina.	do		27.0
Do	Steel Creek	Footbridge 100 yards above mouth, North Carolina.	do	3.20	100.21
Sept. 25	Johns River	Collettsville, N. C	N. C. Curtis	4.77	40.0
Nov. 6	do	do	do	4.47	135.0
Sept. 25	Mulberry Creek	At mouth, North Carolina	do	7.85	17.0
Nov. 6	do	do	do	7.95	39.0
Do	Wilson Creek	do	do	0.75	208.0
June 13	Lower Creek	Two miles above mouth, North Carolina.	E. W. Myers	14.58	209.0
July 6	do	do	L. V. Branch		132.0
Aug. 8	do	do	N. C. Curtis		69.0
Sept. 24	do	do	do	15.38	56.0

Miscellaneous discharge measurements of Broad River (of the Carolinas) and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Aug. 28	Broad River	Ford 1 mile above mouth of Second Broad River, North Carolina.	H. A. Pressey	5.95	649.0
Aug. 25	do	McClure's bridge, North Carolina.	N. C. Curtis	23.43	220.0
Oct. 18	do	do	do	22.67	434.0
Aug. 22	do	Near mouth of Buffalo Creek, North Carolina.	do	15.2	57.1
Oct. 6	do	do	do	14.59	145.4
Aug. 21	do	Bridge at Batcave post-office, N. C.	do		50.1
Do	do	do	do	10.15	48.0
Oct. 6	do	do	do	10.45	62.4
Aug. 21	Hickory Nut Creek	At mouth, North Carolina	do	4.80	15.2
Do	Reedy Patch Creek	do	do	5.75	13.0
Aug. 22	Buffalo Creek	Fifteen yards below main ford, North Carolina.	do	4.10	17.0
Do	Cove Creek	Bridge at Rutherfordton road, North Carolina.	do	18.65	69.3
Oct. 6	do	do	do	18.16	86.0
Aug. 25	Mountain Creek	Near mouth, North Carolina	do	6.83	55.3
Oct. 8	do	do	do	6.48	70.2
Aug. 25	Maple Creek	do	do	7.70	8.4

Miscellaneous discharge measurements of Broad River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Aug. 25	Green River	Cox's bridge, North Carolina	N. C. Curtis	22.9	299.0
Oct. 8	do	do	do	22.6	255.4
Sept. 3	do	Near Saluda, on Howard Gap road, North Carolina.	do	17.7	74.1
Do	Cove Creek	Near mouth, North Carolina	do	5.40	19.2
Aug. 31	White Oak Creek	One-half mile above mouth, North Carolina.	do	4.65	64.0
Aug. 23	Second Broad River	One and one-half miles east of Forest City, N. C.	do	20.8	153.3
Oct. 5	do	do	do	20.32	188.3
Aug. 24	do	Bridge on Rutherfordton-Morganton road, North Carolina.	do	7.35	55.0
Oct. 4	do	do	do	7.00	64.0
Aug. 24	Cane Creek	One mile above mouth, North Carolina.	do	5.43	17.0
Aug. 23	Cathey Creek	At mouth, North Carolina	do	3.35	42.0
Do	Hollins Creek	do	do	5.8	14.3
Aug. 24	Robersons Creek	do	do		24.0
Aug. 23	Puzzle Creek	Near mouth, North Carolina	do	6.70	10.0
Aug. 30	First Broad River	do	do	17.7	285.3
Oct. 10	do	do	do	16.2	266.4

Miscellaneous discharge measurements of South Saluda Creek and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 7	South Saluda Creek	Freeman Bridge, below mouth of Middle Saluda Creek, North Carolina.	N. C. Curtis	14.1	223.0
Oct. 14	do	do	do	14.1	171.0
Sept. 7	do	Two miles above mouth of Middle Saluda Creek, North Carolina.	do	6.0	188.0
Oct. 14	do	do	do	6.0	134.0
Sept. 7	Middle Saluda Creek	One mile above mouth, North Carolina.	do	11.75	68.0
Oct. 13	do	do	do		55.0
Sept. 7	North Saluda Creek	Iron bridge at Marietta, N. C.	do	14.7	58.2
Oct. 13	do	do	do	14.17	80.0
Sept. 6	do	Bridge on Lima-Cleveland Mills road, North Carolina.	do	12.9	56.1
Do	do	Two miles below Humphrey's store, North Carolina.	do	14.2	26.1
Do	Fall Creek	Bridge on road to Lima, N. C.	do		*a* 15.0

a Estimated.

Miscellaneous discharge measurements of Tugaloo River tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Dec. 21	South Prong of Panther Creek.	Near Turnerville, Ga	J. C. Conn	8.8
Do	Panther Creek	do	do	33.5
Do	Tiger Creek	Nine miles north of Tallulah Falls, Ga.	do	18.2
Dec. 22	do	Six miles south of Clayton, Ga	do	11.8
Do	Scott Creek	Clayton, Ga	do	9.0
Do	Timpson Creek	Five miles from Clayton, Ga	do	12.2
Dec. 23	Tallulah River	Burton, Ga	do	263.1
Dec. 24	Stekoa Creek	One mile east of Clayton, Ga	do	9.9
Do	Chattooga River	Rogers Ford, Georgia	do	273.5

Miscellaneous discharge measurements of Broad River (of Georgia) and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Dec. 19	Grove Creek	Maysville, Ga	J. C. Conn	29.4
Do	Hickory Level Creek	do	do	20.3
Dec. 20	Little Hudson Creek	Homer, Ga	do	147.3
Do	Little Nails Creek	do	do	9.1
Dec. 26	North Broad River	Three and one-half miles south of Toccoa, Ga.	do	7.8
Do	Davis Creek	Four miles south of Toccoa, Ga	do	2.3
Do	Leatherwood Creek	Eight and one-half miles south of Toccoa, Ga.	do	8.3
Do	Little Leatherwood Creek.	Ten miles south of Toccoa, Ga	do	6.5
Do	Middle Broad River	Ten miles northeast of Homer, Ga	do	96.6
Do	Little Hudson River	One mile north of Homer, Ga	do	82.0
Dec. 27	Hickory Level Creek	Three miles south of Maysville, Ga	do	26.5
Do	Grove Creek	Two and one-half miles northeast of Maysville, Ga.	do	28.5

Miscellaneous discharge measurements of Savannah River tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 30	Hollow Creek	Kathwood, S. C	B. M. Hall		123.0
May 2	South Broad River	Near Carlton, Ga	Max Hall	3.20	200.0
Oct. 18	Broad River	Baker's ferry, about 25 miles below Carlton, Ga.	do	2.20	949.0

Miscellaneous discharge measurements of Oconee River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Aug. 27	Oconee River	Carey, Ga	W. E. Hall	2.37	1,199.0
Dec. 27	do	do	Max Hall	3.00	1,566.0
Dec. 28	do	Milledgeville, Ga	do	3.44	2,349.0
Dec. 18	Appalachee River	Dacula, Ga	J. C. Conn		11.4
Dec. 19	Cedar Creek	Hoschton, Ga	do		27.3
Do	Walnut River	Pendergrass, Ga	do		66.8
Do	Middle Oconee River	do	do		70.3
Do	Hurricane Creek	Dry Pond, Ga	do		6.5
Do	North Oconee River	do	do		72.8
Dec. 27	do	do	do		103.8
Do	Hurricane Creek	do	do		3.2
Do	Middle Oconee River	Pendergrass, Ga	do		61.4

Miscellaneous discharge measurements of Ocmulgee River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Oct. 10	Yellow River	Near Stone Mountain, Ga	Max Hall	112.0
Dec. 18	Stone Mountain Creek.	Stone Mountain, Ga	J. C. Conn	18.1
Do	Haynes Creek	Snellville, Ga	do	2.0
Do	Big Creek	Tripp, Ga	do	3.9
Do	Shoal Creek	Bramlett Shoals, Georgia	do	9.3
Do	Alcovy River	do	do	33.7
Dec. 28	do	do	do	34.5
Do	*Shoal Creek	do	do	8.5
Do	Yellow River	Annistown, Ga	do	151.7

Miscellaneous discharge measurements of Chattahoochee River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 20	Cane Creek	Near Dahlonega, Ga	W. E. Hall and H. G. Stokes.	28.6
Do	Yahoola Creek	do	do	66.0
Do	Chestatee River	do	do	287.0
Do	Singleton ditch	do	do	1.8
Do	Yahoola ditch	do	do	30.4
Do	Yahoola Creek	Five miles above Dahlonega, Ga	do	22.7
Do	Cane Creek	Five miles north of Dahlonega, Ga	do	13.3
Do	Wards Creek	At mouth, Georgia	do	5.0
Aug. 21	Charles Creek	Near Louisville, Ga	do	9.0
Do	Tates Creek	One mile above mouth, Georgia	do	8.0
Do	Mill Creek	Near mouth, Georgia	do	5.0
Do	Turner Creek	do	do	20.0
Do	Shoal Creek	Above mining ditch, Georgia	do	23.0
Do	Chestatee River	Below Turner Creek, Georgia	do	69.0
Aug. 22	Town Creek	Six miles above mouth, Georgia	do	23.0
Do	do	Two miles above mouth, Georgia	do	57.0
Do	Loud ditch	Near Henesey, Ga	do	7.3
Do	Jennies Creek	Near Pleasant Retreat, Ga	do	21.7
Do	E. Tessantee Creek	At mouth, Georgia	do	70.2
Do	Tessantee River	Near Pleasant Retreat, Ga	do	142.0
Do	Shoal Creek	Near mouth, Georgia	do	9.7
Aug. 23	Dukes Creek	Two miles above mouth, Georgia	do	55.0
Do	Chattahoochee River	Nacoochee, Ga	do	80.5
Do	Santee Creek	At mouth, Georgia	do	69.0
Do	Soque River	Porter Mills, Georgia	do	212.0
Do	Flat Shoals Creek	Johnson's mill, near West Point, Ga	Max Hall	113.0
Aug. 24	Little River Creek	Near Land, Georgia	W. E. Hall and H. G. Stokes.	12.3
Dec. 21	Glades Creek	Five miles northeast of Demorest, Ga	J. C. Conn	62.9
Do	Hazel Creek	Demorest, Ga	do	92.7

Miscellaneous discharge measurements of Etowah River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 14	Little River	Arnold's mill, Georgia	W. E. Hall and H. G. Stokes.	56.3
Do	Smithwick Creek	Between Arnold's mill, Georgia, and Creighton, Ga.	do	8.0
Do	Buzzard Flopper Creek.	do	do	8.0
Do	Board Tree Creek	do	do	8.0
Do	Sittingdown Creek	Creighton, Ga	do	54.4
Aug. 15	Etowah River	Near Hightower, Ga	do	664.0
Do	Cogburns Creek	do	do	12.0
Do	Yellow Creek	Near mouth, Georgia	do	45.7
Do	Amicalola River	About 3 miles above mouth, Georgia	do	241.0
Aug. 16	Spriggs Creek	One mile below Summerour place, Georgia.	do	21.3
Do	Little Amicalola Creek.	Below Amicalola Falls, Georgia	do	4.3
Do	Big Amicalola Creek	Near Afton post-office, Ga	do	83.0
Aug. 17	Spriggs Creek	Near Juno post-office, Ga	do	27.7
Do	Carder Creek	Near mouth, Georgia	do	16.2
Do	Parks Creek	do	do	16.0
Do	Pigeon Creek	Near Dawsonville, Ga	do	7.6
Do	Shoal Creek	do	do	34.6
Do	Etowah River	Near Auraria, Ga	do	257.0
Do	West Amicalola Creek.	Langston Ford, Georgia	B. M. Hall	15.9
Do	Crane Creek	Below Amicalola Falls, Georgia	do	6.5
Aug. 18	Carder Creek	Near Emma, Ga	do	9.0
Do	Spriggs Creek	At Spriggs Ford, Georgia	do	14.0
Do	Parks Creek	Near Parks place, Georgia	do	7.3
Do	Mill Creek	Near mouth, Georgia	W. E. Hall and H. G. Stokes.	34.0
Do	Nimblewill Creek	One mile above mouth, Georgia	do	40.6
Do	Etowah River	Below mouth of Nimblewill Creek, Georgia.	do	132.0
Aug. 21	Montgomery Creek	Near Randa, Ga	do	10.4
Sept. 25	Etowah River	Near Cartersville, Ga	Max Hall	a1,235.0
Do	Petits Creek	do	do	16.0
Do	Pumpkin Vine Creek	do	do	60.5
Nov. 15	Town Creek	Alice, Ga	O. P. Hall	6.7

a Gage height, 2 feet.

Miscellaneous discharge measurements of Coosawattee River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 13	Sugar Creek	Near Ramsey, Ga	O. P. Hall	4.0
Aug. 17	Clontz Creek	Southern's ford, Georgia	B. M. Hall	17.8
Oct. 18	Talking Rock Creek	Near Carters, Ga	O. P. Hall	91.0
Do	Harris Creek	Goble, Ga	do	3.4
Do	Worley Creek	At mouth, Georgia	do	6.5
Do	Crawfords Creek	do	do	5.0
Oct. 19	Tails Creek	do	do	27.0
Do	Flat Creek	do	do	19.0
Oct. 20	Cartecay River	Ellijay, Ga	do	165.0
Do	Ellijay River	do	do	129.0
Do	Cox Creek	do	do	2.2
Do	Mill Creek	Near Ellijay, Ga	do	3.0
Do	Clonegar Creek	Five miles above Ellijay, Ga	do	3.0
Do	Clear Creek	One mile above mouth, Georgia	do	7.5
Do	Turkey Creek	One mile above mouth of Clear Creek, Georgia.	do	12.9
Oct. 22	Lick Log Creek	Cartecay, Ga	do	16.3
Oct. 24	Anderson Creek	One mile above mouth, Georgia	do	70.0
Do	Tickanetley River	One mile above mouth of Anderson Creek, Georgia.	do	101.0
Do	Pumpkin Creek	Near Tickanetley, Ga	do	29.8
Do	Downing Creek	One and one-half miles above forks, Georgia.	do	23.6
Do	Rawlston Creek	Near mouth, Georgia	do	27.5
Do	Branch of Cartecay River.	Entering Cartecay River, 9 miles above Ellijay, Ga.	do	4.6
Do	Scrongetown Creek	Near mouth, 7 miles above Ellijay, Ga	do	7.7
Oct. 25	Owltown Creek	At mouth, 3 miles above Ellijay, Ga	do	15.0
Do	Big Turniptown Creek.	Above mouth of Little Turniptown Creek, Georgia.	do	17.4
Do	Little Turniptown Creek.	One mile above mouth, Georgia	do	1.9
Do	White Path Creek	At railroad crossing, Georgia	do	5.3
Do	Branch of Briar Creek.	Whitepath, Ga	do	.8
Do	Briar Creek	One and one-half miles north of Whitepath, Ga.	do	3.0
Do	Rock Creek	One mile above mouth, Georgia	do	32.5
Do	Cherry Log Creek	Near mouth, Georgia	do	21.9
Oct. 26	Boardtown Creek	do	do	28.1
Do	Parks Creek	At Boardtown road, Georgia	do	2.4
Do	Branch of Kells Creek.	Near mouth, Georgia	do	1.5
Do	Kells Creek	Above mouth, Georgia	do	10.6
Do	Branch of Ellijay River.	Near mouth, Georgia	do	3.0
Do	Ellijay River	At bridge 1½ miles above Ellijay, Ga	do	175.7
Oct. 27	Cartecay River	At railroad bridge at Ellijay, Ga	do	263.2
Do	Mountaintown Creek.	Above fork at Ratcliff, Ga	do	37.3
Do	Middle Prong of Mountaintown Creek.	Near mouth, Georgia	do	17.9
Do	West Prong of Mountaintown Creek.	Above mouth of Middle Prong, Georgia.	do	23.2

Miscellaneous discharge measurements of Conasauga River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
May 15	Conasauga River	Near Resaca, Ga	O. P. Hall	420.0
Aug. 13	Rock Creek	Ramsey, Ga	do	7.4
Sept. 7	do	do	do	4.2
Aug. 13	Holly Creek	Near Fort Mountain, Georgia	do	13.8
Sept. 6	do	do	do	13.5
Aug. 13	Mill Creek	Dunn, Ga	do	3.0
Aug. 14	Sumach Creek	North Prong at Long Bridge, Georgia	do	3.2
Do	do	South Prong at Long Bridge, Georgia	do	3.6
Sept. 6	do	do	do	4.1
Do	do	North Prong at Long Bridge, Georgia	do	3.4
Aug. 14	Conasauga River	Alaculsy, Ga	do	16.2
Sept. 6	do	do	do	10.7
Aug. 14	Jacks River	Near Alaculsy, Ga	do	30.6
Sept. 5	do	do	do	24.8
Aug. 15	Sheets Creek	do	do	2.0

Miscellaneous discharge measurements of Coosa River tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 15	Talladega Creek	Kymulga, Ala	J. R. Hall	107.0
Aug. 16	Tallesschatchee Creek	Childersburg, Ala	do	102.0
Aug. 17	Hatchett Creek	Goodwater, Ala	do	84.0

Miscellaneous discharge measurements of Tallapoosa River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec. ft.*
Apr. 7	Tallapoosa River	Muscadine, Ala	J. C. Conn	475.0
Aug. 2	Longahatchee Creek	Meader's bridge, Alabama	J. R. Hall	125.0
Aug. 3	Blue Creek	Susanna, Ala	do	34.0
Aug. 28	Elkhatchee Creek	Island Home, Ala	do	40.0
Aug. 30	Timber Cut Creek	Welche's ferry, Alabama	do	18.6
Nov. 1	Tallapoosa Creek	Cherokee Bluff, Alabama	do	3,650.0
Dec. 12	Chattasatkee Creek	Dadeville, Ala	do	35.0
Do	Sandy Creek	Near Dadeville, Ala	do	145.0

Miscellaneous discharge measurements of New River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec. ft.*
July 18	South Fork of New River.	Riverside, N. C	N. C. Curtis	11.85	165.0
Oct. 25	do	do	do	11.00	741.1
July 23	Flannery Fork	Ford of Boone-Blowing Rock road, North Carolina.	do	6.35	10.4
Oct. 24	do	do	do	5.35	107.0
July 23	Middle Fork	Ford of Boone-Aho road, North Carolina.	do	5.70	24.4
Oct. 24	do	do	do		234.0
July 23	East Fork	do	do	5.70	10.4
Oct. 24	do	do	do	5.10	109.0
July 18	Meat Camp Creek	One-fourth mile below Moretz, N. C.	do	9.00	35.3
Oct. 25	do	do	do	8.65	89.0
July 24	Elk Creek	Elk crossroads, North Carolina.	do	8.00	10.0
July 18	Old Field Creek		do	6.1	19.4
July 24	Gap Creek	One-eighth mile above mouth, North Carolina.	do	4.85	23.4
July 19	Beaver Creek	At mouth, North Carolina	do	6.00	22.4
July 27	Mulberry Creek	Near mouth, North Carolina	do	5.1	109.0
Do	Prather Creek	One and one-half miles below Scottville, N. C.	do	8.6	25.0
July 21	North Fork of New River.	One mile below Creston, N. C.	do	6.7	49.3
Oct. 26	do	do	do	6.0	194.0
July 20	do	One-half mile from Creston, N. C., on road to Solitude, N. C.	do	2.65	32.2
Do	Three Top Creek	Creston, N. C	do	6.75	130.0
July 21	do	do	do	7.25	37.0
July 20	Big Laurel Creek	One hundred yards above mouth, North Carolina.	do	6.40	26.2
Oct. 26	do	do	do	6.30	80.4
July 20	Buffalo Creek	One-eighth mile above mouth, North Carolina.	do	5.43	44.0
Oct. 26	do	do	do		67.0
July 25	Horse Creek	One-fourth mile above mouth, North Carolina.	do	6.6	34.3
Oct. 27	do	do	do	6.05	140.0
July 25	Helton Creek	Below Peasley's mill, North Carolina.	do	4.28	30.0
Oct. 27	do	do	do		105.0
July 28	Wilson Creek	Two miles above mouth, Virginia.	do	6.3	35.1
Oct. 28	do	do	do	6.1	78.0

Miscellaneous discharge measurements of New River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
July 29	Fox Creek	One-fourth mile above mouth, Virginia.	N. C. Curtis		85.0
Oct. 28	do	do	do		144.0
July 31	Peach Bottom Creek	Two hundred yards above mouth, Virginia.	do	4.9	21.4
Oct. 29	do	do	do		36.0
July 31	Little River	Ford of Independence-Oldtown road, Virginia.	do	9.1	199.0
Oct. 29	do	do	do		318.2
July 30	Elk Creek	Two hundred yards above mouth, Virginia.	do	4.0	57.[illegible]8

Miscellaneous discharge measurements of French Broad River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 7	French Broad River.	One half mile above Hot Springs, N. C.	L. V. Branch	19.35	938.0
Sept. 12	do	Alexander, N. C	E. W. Myers	17.15	840.0
Oct. 29	do	do	L. V. Branch	16.27	2,068.0
Sept. 18	do	Fanning Bridge, North Carolina.	N. C. Curtis	16.22	1,161.0
Oct. 17	do	do	do	16.95	614.0
Sept. 17	do	Penrose, N. C	do	19.8	1,160.0
Sept. 13	do	Near Carson Creek, N. C.	do	13.8	266.5
Oct. 15	do	do	do	13.9	206.5
Sept. 14	do	Eastatoe Bridge, North Carolina.	do	12.4	113.0
Oct. 15	do	do	do	11.21	102.4
Sept. 14	North Fork of French Broad River.	Two hundred yards above mouth of West Fork, North Carolina.	do		100.6
Oct. 15	do	do	do	13.2	51.8
Sept. 16	do	Bridge on Brevard-Webster road, North Carolina.	do	14.98	107.48
Do	do	Ford on road between Tucker and Shoal creeks, North Carolina.	do	7.3	75.0
Sept. 14	West Fork of French Broad River.	Near mouth, North Carolina	do	2.20	149.0
Oct. 15	do	do	do		62.0
Sept. 14	Middle Fork of French Broad River.	Bridge 20 yards above ford, North Carolina.	do	5.35	77.0
Do	South Fork of French Broad River.	Footbridge at ford of main road, North Carolina.	do	10.3	71.0
Oct. 15	East Fork of French Broad River.	Near mouth, North Carolina	do	10.2	46.0
Sept. 16	Tucker Creek	Two hundred yards above mouth, North Carolina.	do	4.61	23.0
Sept. 13	Cathey Creek	Ford of Brevard-Jeptha road, North Carolina.	do	6.7	30.2
Sept. 17	King Creek	Brevard road, North Carolina.	do	4.71	15.46
Do	Davidson River	Near mouth, North Carolina	do	16.45	151.7
Oct. 16	do	do	do	16.75	70.20
Sept. 17	Little River	Three-fourths mile above mouth, North Carolina.	do	13.66	182.8
Oct. 16	do	do	do	14.35	69.2
Sept. 17	Boylston Creek	Near mouth, North Carolina	do	5.35	28.6
Do	Mills River	Bridge on Old Haywood road, North Carolina.	do	13.11	211.6
Oct. 17	do	do	do	13.4	94.0
Sept. 18	Mud Creek	Near mouth, North Carolina	do	5.11	108.0
Do	Caney Creek	Bridge on Westfall's place, North Carolina.	do	10.1	60.0
Do	Avery Creek	Bridge on road from Mills River to Asheville, N. C.	do	6.56	11.31
Sept. 19	Hominy Creek	Asheville, N. C	do	15.1	80.0
Oct. 17	do	do	do	15.4	24.0
Sept. 19	Swannanoa River	Biltmore, N. C	do	2.91	76.33

Miscellaneous discharge measurements of French Broad River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 20	North Fork of Swannanoa River.	Three miles above Swannanoa post-office, N. C.	N. C. Curtis	16.07	21.45
Do	Flat Creek	Two miles below Black Mountain Station, N. C.	do	4.05	22.83
Sept. 12	Beaver Dam Creek	Fifty yards above mouth, North Carolina.	E. W. Myers	5.09	1.46
Oct. 30	do	do	L. V. Branch	5.08	4.10
Sept. 16	Lees Creek	Olivette, N. C	E. W. Myers	11.15	3.95
Oct. 30	do	do	L. V. Branch	10.95	2.29
Sept. 12	Newfound Creek	At mouth, North Carolina	E. W. Myers	17.75	9.41
Sept. 16	do	Three-fourths mile above mouth, North Carolina.	do	10.19	34.16
Oct. 30	do	do	L. V. Branch	10.44	20.23
Sept. 12	Reams Creek	At mouth, North Carolina	E. W. Myers	12.1	4.89
Oct. 30	do	do	L. V. Branch		9.0
Sept. 11	Flat Creek	do	E. W. Myers	18.05	5.33
Oct. 29	do	do	L. V. Branch	17.43	5.0
Sept. 12	Sandy Mush Creek	Bailey, N. C	E. W. Myers	9.73	21.72
Sept. 17	do	do	do	9.43	55.23
Oct. 30	do	do	L. V. Branch	9.53	45.0
Sept. 16	Turkey Creek	Blackwell Springs, N. C	E. W. Myers	7.97	35.24
Oct. 30	do	do	L. V. Branch	8.32	16.24
Sept. 17	Big Ivy River	One-eighth mile below mouth of Bull Creek, North Carolina.	E. W. Myers	2.55	47.50
Oct. 29	do	do	L. V. Branch	2.72	41.72
Sept. 8	Little Pine Creek	One hundred yards above mouth, North Carolina.	do	5.84	3.33
Oct. 31	do	do	do	5.76	6.0
Sept. 8	Pawpaw Creek	One mile above mouth, North Carolina.	do	4.6	0.35
Sept. 10	Walnut Creek	At mouth, North Carolina	do	23.24	1.36
Oct. 31	do	do	do	2.35	2.24
Sept. 8	Big Pine Creek	One hundred yards above mouth, North Carolina.	do	6.07	4.85
Oct. 31	do	do	do	6.01	4.45
Sept. 8	Laurel Creek	Two hundred yards above mouth, North Carolina.	do	16.13	49.0
Sept. 18	do	do	E. W. Myers	15.77	55.0
Sept. 7	Spring Creek	Near Hot Springs, N. C	L. V. Branch	2.00	15.0
Nov. 1	do	do	do	2.07	16.0
Sept. 7	Shutin Creek	do	do	2.61	0.45

Miscellaneous discharge measurements of Nolichucky River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec. ft.*
Aug. 23	Nolichucky River	Erwin, Tenn	L. V. Branch	20.67	770.0
Sept. 4	do	do	do	21.53	411.0
Aug. 24	Toe River	Near Huntdale, N. C	do	15.89	381.0
Oct. 17	do	do	do	16.12	301.0
July 2	North Toe River	Sprucepine, N. C	H. A. Pressey		323.0
Aug. 26	do	do	L. V. Branch	18.20	105.0
Oct. 21	do	do	do	18.37	78.0
Oct. 25	do	do	do	17.15	570.0
Aug. 27	do	Plumtree, N. C	do	7.55	79.0
Do	do	At ford of Linville-Cranberry road, North Carolina.	do	3.6	18.0
Do	Kentucky Fork of North Toe River.	At mouth, North Carolina	do	2.85	9.7
Do	White Oak Creek	do	do	2.26	3.36
Aug. 28	Horse Creek	do	E. Graves	5.55	9.03
Oct. 24	do	do	L. V. Branch	5.15	40.53
Aug. 27	Squirrel Creek	One-fourth mile above mouth, North Carolina.	do	3.12	11.2
Do	Roaring Creek	At mouth, North Carolina	do	7.89	15.57
Do	Plum Tree Creek	Plumtree, N. C	do	2.99	8.09
Do	Henson Creek	At mouth, North Carolina	do	6.94	4.8
Aug. 26	Threemile Creek	Near old post-office at Elsie, N. C.	do	5.38	2.63
Oct. 21	do	do	do	5.30	3.57
Aug. 26	Beaver Creek	Near Sprucepine, N. C	do	4.50	3.29
Oct. 21	do	do	do	4.29	3.08
Aug. 26	Grassy Creek	Sprucepine, N. C	do	5.21	6.09

Miscellaneous discharge measurements of Nolichucky River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Oct. 20	Grassy Creek	Sprucepine, N. C.	L. V. Branch	5.13	9.15
Aug. 26	Bear Creek	Flatrock, N. C.	do	3.76	4.67
Oct. 20	do	do	do	3.70	3.73
Aug. 25	Snow Creek	Wing, N. C.	do	3.03	2.0
Do	Crabtree Creek	Ford of Burnsville-Sprucepine road, North Carolina.	do	7.97	15.2
Oct. 20	do	do	do	7.91	14.55
Aug. 25	Brush Creek	Lower ford of Burnsville-Sprucepine road, North Carolina.	do	1.39	4.37
Oct. 20	do	do	do	1.51	.72
Aug. 24	Cane Creek	One-half mile above mouth, North Carolina.	do	9.20	11.78
Oct. 19	do	do	do	9.26	9.92
Sept. 3	Pigeon Creek	At mouth, North Carolina	do	5.86	1.65
Oct. 19	do	do	do	5.85	1.26
Sept. 3	Jack Creek	do	do	6.09	8.71
Oct. 19	do	do	do	6.10	6.83
Aug. 24	Big Rock Creek	Ford of Huntdale-Bakersville road, North Carolina.	do	2.42	51.3
Oct. 19	do	do	do	2.64	24.5
Aug. 24	Pigeon Roost Creek	At mouth, North Carolina	do	7.39	14.5
Oct. 19	do	do	do	7.47	4.12
Aug. 23	Hollow Poplar Creek	Ford of Erwin-Bakersville road, North Carolina.	do	8.15	5.98
Oct. 16	do	do	do	8.26	2.61
Aug. 23	South Indian Creek	Near Erwin, Tenn	do	5.38	52.3
Sept. 4	do	do	do	5.49	33.2
Sept. 19	do	do	E. W. Myers	5.40	53.0
Aug. 23	Martin Creek	do	L. V. Branch	1.59	7.55
Sept. 4	do	do	do	1.68	6.45
Aug. 22	North Indian Creek	Erwin, Tenn	do	3.95	51.0
Sept. 4	do	do	do	4.19	22.0
Sept. 19	do	do	E. W. Myers	4.05	29.7
Oct. 16	do	do	L. V. Branch	4.18	26.13
Aug. 22	do	Unicoi, Tenn	do	4.58	37.9
Do	Rock Creek	One hundred yards above mouth, Tennessee.	do	3.69	6.37
July 1	South Toe River	Ford of Micaville-Sprucepine road, North Carolina.	H. A. Pressey		220.8
Aug. 25	do	do	L. V. Branch	8.08	79.8
Aug. 30	do	do	do	7.98	86.23
Oct. 27	do	do	do	7.23	282.9
Aug. 31	do	One mile above mouth of Three Fork Creek, North Carolina.	do	4.34	26.0
Oct. 26	do	do	do	3.30	101.6
Aug. 31	Three Fork Creek	One-fourth mile above mouth, North Carolina.	do	1.49	9.49
Do	Rock Creek	Ford of Micaville-Marion road, North Carolina.	do	1.96	6.92
Oct. 26	do	do	do	1.62	28.68
Aug. 31	Middle Creek	do	do	3.94	3.78
Oct. 26	do	do	do	3.64	9.20
Aug. 31	Colbert Creek	do	do	3.87	2.51
Oct. 26	do	do	do	3.50	7.24
Aug. 30	Locust Creek	At mouth, North Carolina	do	1.98	3.83
Oct. 26	do	do	do	1.87	7.96
Aug. 30	Whiteoak Creek	do	do	4.66	4.40
Oct. 26	do	do	do	4.28	19.86
Aug. 30	Brown Creek	Ford of Micaville-Marion road, North Carolina.	do	3.02	4.94
Oct. 26	do	do	do	2.85	9.43
Aug. 30	Little Crabtree Creek.	Just above lower ford of Micaville-Sprucepine road, North Carolina.	do	4.28	17.54
Oct. 27	do	do	do	4.23	21.67
Aug. 30	Cane Branch	Ford of Micaville-Marion road, North Carolina.	do	3.92	2.98
Oct. 26	do	do	do	3.78	8.59
Aug. 24	Caney River	Huntdale, N. C	do	3.69	89.9
Sept. 3	do	do	do	3.82	62.77
Oct. 17	do	do	do	3.83	58.3
Sept. 1	do	Near Big Tom Wilson's, North Carolina.	do	1.33	17.11
Oct. 18	do	do	do	1.34	13.9
Sept. 1	Elk Fork Creek	do	do	1.24	4.73
Oct. 18	do	do	do	1.28	1.49
Sept. 1	Cattail Branch	Near Burnsville, N. C.	do	2.78	2.77
Oct. 18	do	do	do	2.64	4.69

Miscellaneous discharge measurements of Nolichucky River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 1	Bowlen Creek	Near Burnsville, N. C.	L. V. Branch	5.03	3.45
Oct. 18	do	do	do	4.97	4.02
Sept. 2	Price Creek	do	do	2.48	9.46
Oct. 18	do	do	do	2.53	8.35
Sept. 2	Bald Creek	do	do	4.56	16.25
Oct. 18	do	do	do	4.56	9.97
Sept. 2	Elk Shoal Creek	At mouth, North Carolina	do	1.63	1.29
Do	Bald Mountain Creek.	One mile above mouth, North Carolina.	do	3.43	19.7
Oct. 17	do	do	do	3.55	10.6
Sept. 2	Little Bald Mountain Creek.	At mouth, North Carolina	do	4.91	2.12
Oct. 17	do	do	do	4.90	2.61
Sept. 2	Big Creek	do	do	2.83	5.67
Oct. 17	do	do	do	2.89	2.0

Miscellaneous discharge measurements of South Fork of Holston River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
July 23	South Fork of Holston River.	Below mouth of Middle Fork, Virginia.	L. V. Branch	3.06	228.0
Oct. 3	do	do	E. W. Myers	3.21	199.0
July 28	do	Below mouth of Laurel Fork, Virginia.	do	2.60	652.0
Oct. 3	do	do	do	3.39	149.0
July 28	do	Above mouth of Laurel Fork, Virginia.	do	1.51	101.0
Oct. 3	do	do	do		48.0
July 27	do	Rye Valley, Virginia	do	6.96	20.0
Oct. 1	do	do	do		5.0
July 27	Jim Scot Branch	At mouth, Virginia	do		4.12
Oct. 1	do	do	do		0.5
July 27	Pomer Creek	do	do	2.1	39.0
Oct. 1	do	do	do	2.29	5.0
July 27	Hogtrough Creek	Lower ford of main road, Virginia.	do	.87	9.0
Oct. 2	do	do	do		1.0
July 27	St. Clair Creek	At mouth, Virginia	do	5.76	8.27
Oct. 2	do	do	do	5.94	2.0
July 27	Grose Creek	do	L. V. Branch	3.88	2.0
Oct. 2	do	do		(a)	
July 27	Mill Creek	One mile above mouth, Virginia.	do	4.32	18.0
Oct. 2	do	do	E. W. Myers	4.43	13.03
July 28	Rush Creek	Ford 100 yards above mouth, Virginia.	L. V. Branch	3.63	4.20
Oct. 2	do	do	E. W. Myers		2.0
July 28	Laurel Fork of Holston River.	One-half mile below Damascus, Va.	L. V. Branch	3.56	351.0
Oct. 3	do	do	E. W. Myers	4.61	88.14
July 29	do	Near Laurel bloomery, Tennessee.	do	5.12	61.0
Do	do	One-half mile above Laurel bloomery, Tennessee.	do	2.06	23.0
Do	Atcheson Creek	Near head of Laurel, Tenn	do	1.82	4.32
Do	White Top Creek	At mouth, Virginia	do	5.47	100.0
Oct. 2	do	do	do	5.72	34.3
July 28	Beaver Dam Creek	Damascus, Va	do	11.36	189.0
Oct. 3	do	do	do	12.26	32.4
July 23	Fifteenmile Creek	At mouth, Virginia	L. V. Branch	4.45	7.37
Sept. 27	do	do	E. W. Myers	4.23	10.46
July 21	Denton Valley Creek	do	L. V. Branch	5.73	6.0
Sept. 27	do	do	E. W. Myers	5.73	4.04
July 21	Wolf Creek	Lower ford of main road up the river, Virginia.	do	2.35	7.0
July 23	do	do	L. V. Branch	2.36	7.0
Sept. 27	do	do	E. W. Myers	2.21	12.24
July 21	Spring Creek	One mile above mouth, Virginia.	L. V. Branch	.90	13.0
Sept. 27	do	do	E. W. Myers		10.0

a Almost dry.

Miscellaneous discharge measurements of South Fork of Holston River, etc.—Cont'd.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
July 21	Jacobs Creek	At mouth, Tennessee	L. V. Branch	9.1	2.07
Sept. 27	do	do	E. W. Myers		2.0
July 21	Sharp Creek	do	do	5.36	1.16
Sept. 26	do	do	do	5.33	1.19
July 20	Fishdam Creek	do	do	5.25	5.85
Sept. 26	do	do	L. V. Branch	5.26	2.47
July 20	Jonah Creek	do	do	11.06	4.0
Sept. 25	do	do	E. W. Myers	11.42	4.0
July 20	Riddle Creek	do	do	12.19	2.0
Sept. 25	do	do	do	11.13	3.0
Do	Thomas Creek	Below railroad bridge, Tennessee.	do		2.46
July 29	Sinking Creek	At mouth, Tennessee	do	4.92	11.0
Sept. 25	do	do	do	4.42	9.09
July 20	do	One half mile above Paperville, Tenn.	L. V. Branch	3.6	3.48
Sept. 25	Hatcher Creek	One-half mile above mouth, Tennessee.	E. W. Myers	5.92	0.34
July 24	Middle Holston	Five miles above mouth, Virginia.	do	5.96	172.0
Sept. 28	do	do	do	6.21	100.0
July 25	Middle Fork of Holston River.	Sevenmile ford, Virginia	L. V. Branch	13.00	71.23
Do	do	Above mouth of Bear Creek, Virginia.	do	6.23	18.0
Oct. 1	do	do	do	7.69	11.0
July 25	Bear Creek	At mouth, Virginia	do	6.99	2.01
Oct. 1	do	do	E. W. Myers	6.90	3.0
July 25	Staleys Creek	Marion, Va	L. V. Branch	9.26	14.32
Do	Hungry Mother Creek.	Ford of main road from Marion, Va.	do	1.18	2.45
Oct. 1	do	do	E. W. Myers	1.17	2.36
July 25	Byars Creek	At mouth, Virginia	L. V. Branch	1.52	4.0
Sept. 29	do	do	E. W. Myers	1.58	2.24
July 25	Walker Creek	Fifty yards above mouth, Virginia.	do	4.90	3.0
Sept. 29	do	do	do	4.89	9.0
July 23	Huttons Branch	At mouth, Virginia	L. V. Branch	4.45	5.0
Sept. 29	do	do	E. W. Myers	4.43	5.0
Do	Halls Creek	do	do	1.73	17.36
Do	Cedar Creek	do	do		3.42
July 24	Hogthief Creek	One-half mile above mouth, Virginia.	L. V. Branch	5.0	5.0
Sept. 29	do	do	E. W. Myers		5.0

Miscellaneous discharge measurements of Watauga River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
July 16	Watauga River	Elizabethton, Tenn	E. W. Myers	15.87	450.0
Aug. 2	do	do	L. V. Branch	15.77	593.0
Aug. 16	do	do	do	16.03	403.0
Oct. 5	do	do	E. W. Myers	16.03	348.0
Nov. 7	do	do	L. V. Branch	15.27	993.0
Dec. 28	do	do	E. W. Myers	15.68	533.0
Dec. 31	do	do	Ernest Graves	15.22	973.0
July 16	do	Watauga Falls, N. C	N. C. Curtis		79.0
Aug. 10	do	do	L. V. Branch	6.62	53.0
Oct. 7	do	do	E. W. Myers	6.52	60.0
Aug. 11	do	One mile above Shull's mill, North Carolina.	L. V. Branch	4.05	19.0
Oct. 7	do	do	E. W. Myers	3.78	23.0
Aug. 10	Boone Fork of Watauga River.	Shull's mill, North Carolina	L. V. Branch	2.3	12.0
Oct. 7	do	do	E. W. Myers	2.11	13.0
Aug. 11	Moody Mill Creek	At mouth, North Carolina	L. V. Branch	3.2	4.0
Aug. 10	Laurel Creek (upper).	do	do	2.62	10.0
Oct. 7	do	do	E. W. Myers	2.87	6.0
Aug. 10	Dutch Creek	Valle Cruces, N. C	L. V. Branch	7.42	11.0
Oct. 7	do	do	E. W. Myers	7.37	6.0
Aug. 10	Cove Creek	At mouth, North Carolina	L. V. Branch	5.24	12.0
Oct. 7	do	do	E. W. Myers	5.15	14.0

Miscellaneous discharge measurements of Watauga River, etc.—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Aug. 12	Cove Creek	Above mouth of Brushy Fork, North Carolina.	L. V. Branch	4.31	23.0
Do	Brushy Fork of Cove Creek.	At mouth, North Carolina	do	2.06	5.19
Do	Rockhouse Creek	do	do	2.17	16.3
Oct. 18	do	do	E. W. Myers		0.8
Aug. 10	Laurel Creek (lower)	do	L. V. Branch	10.62	4.0
Oct. 7	do	do	E. W. Myers		3.09
Aug. 9	Beaver Dam Creek	Near Leander, N. C.	L. V. Branch	5.59	7.0
Oct. 6	do	do	E. W. Myers		8.0
Aug. 9	Beech Creek	Above mouth of Fogey Creek, North Carolina.	L. V. Branch	5.6	7.3
Oct. 6	do	do	E. W. Myers	5.7	7.4
Aug. 9	Fogey Creek	At mouth, North Carolina	L. V. Branch	2.94	1.4
Oct. 6	do	do	E. W. Myers	3.02	2.4
Aug. 9	Big Dry Run	One-eighth mile above mouth, North Carolina.	L. V. Branch	1.55	0.85
Aug. 6	Elk Creek	One-half mile below mouth of the Little Elk, Tennessee.	do	7.21	64.0
Aug. 11	South Fork of Elk Creek.	At Banners Elk, North Carolina.	do	11.96	9.38
Oct. 8	do	do	E. W. Myers	11.82	8.48
Aug. 12	North Fork of Elk Creek.	do	L. V. Branch	5.61	7.0
Oct. 8	do	do	E. W. Myers	5.64	4.0
Aug. 4	Cranberry Creek	Cranberry, N. C.	L. V. Branch	6.95	5.09
Do	Blevins Creek	do	do	6.08	5.05
Aug. 6	Little Elk Creek	At mouth, North Carolina	do	1.2	6.0
Do	Dark Ridge Creek	One-half mile above mouth, Tennessee.	do	4.65	3.0
July 30	Roan Creek	Above mouth of Mill Creek, Tennessee.	E. W. Myers	5.7	60.3
Aug. 13	do	Key Station, Tenn.	L. V. Branch	4.85	5.2
Do	Forge Creek	Near mouth, Tennessee	do	4.53	7.0
July 29	Town Creek	At Shoun crossroads, Tennessee.	do	3.48	29.2
Aug. 13	do	do	do	3.82	6.0
July 30	Mill Creek	At mouth, Tennessee	E. W. Myers	9.48	13.0
Do	Doe Creek	Mouth of Doe (town), Tenn.	do	5.23	59.0
Aug. 13	do	do	L. V. Branch	5.49	26.2
Oct. 9	do	do	E. W. Myers	5.46	28.38
Aug. 13	do	Ivyspring post-office, Tennessee.	L. V. Branch	5.94	9.0
Aug. 3	Stony Creek	One-half mile above mouth, Tennessee.	do	6.95	44.0
Oct. 5	do	do	E. W. Myers	7.59	16.0
Dec. 31	do	do	Ernest Graves	4.60	48.0
Aug. 2	Doe River	Above Elizabethton, Tenn.	L. V. Branch	5.94	143.4
Aug. 17	do	do	do	6.20	106.0
Oct. 5	do	do	E. W. Myers	6.23	82.0
Dec. 31	do	do	Ernest Graves	5.23	304.0
Aug. 8	do	Near Allentown, Tenn	L. V. Branch	5.56	72.0
Aug. 18	do	do	do	5.81	50.0
Oct. 5	do	do	E. W. Myers	5.85	39.3
Aug. 3	do	Two miles below Roan Mountain, Tennessee.	L. V. Branch	8.46	41.3
Do	Shell Creek	At mouth, Tennessee	do	2.35	14.0
Do	Wilson Creek	One mile above mouth, Tennessee.	do	3.67	5.0
Do	Little Doe River	Allentown, Tenn	do	4.42	35.0
Oct. 5	do	do	E. W. Myers	4.78	17.0
Dec. 29	do	do	do	4.30	28.3
Aug. 3	Laurel Fork of Doe River.	do	L. V. Branch	5.19	30.0
Aug. 17	do	do	do	5.50	15.0
Oct. 5	do	do	E. W. Myers	5.67	9.0
Dec. 29	do	do	do	5.05	27.0
Aug. 2	Gap Creek	At mouth, Tennessee	L. V. Branch	4.69	7.0
Oct. 4	do	do	E. W. Myers	4.12	3.0
Aug. 2	Buffalo Creek	do	L. V. Branch	5.85	20.0
Oct. 4	do	do	E. W. Myers	5.92	10.0
Aug. 2	Sinking Creek	Lower ford of Johnson City—Elizabethton road, Tennessee.	L. V. Branch	3.73	5.0
Oct. 4	do	do	E. W. Myers	3.75	4.0
July 19	Brush Creek	Near Carter, Tenn	L. V. Branch	6.77	10.03
Aug. 16	do	do	do	6.82	9.47
Sept. 24	do	do	E. W. Myers	6.94	5.14

Miscellaneous discharge measurements of tributaries of Tennessee River above Hiwassee River.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 20	Tellico River	Tellico Plains, Tenn	O. P. Hall	82.0
Do	Cane Creek	Belltown, Tenn	do	2.0
Do	Ball Play Creek	Tariffville, Tenn	do	2.2
Do	Citico Creek	Lillian, Tenn	do	17.2
Sept. 1	do	do	do	15.8
Aug. 20	Mulberry Creek	Ipe, Tenn	do	5.5
Aug. 21	Little Tennessee River.	Chilhowee, Tenn	do	1,751.0
Sept. 1	do	do	do	2,115.0
Aug. 21	Abrams Creek	do	do	40.2
Aug. 31	do	do	do	35.2
Aug. 22	Hesse Creek	Millers, Tenn	do	4.8
Aug. 23	Big Spring Creek	Tuckaleechee Cove, Tenn	do	4.3
Do	Near Prong of Little River.	do	do	29.5
Do	Main Prong of Little River.	do	do	92.6
Aug. 30	do	do	do	112.5
Aug. 24	Walden Creek	Henderson Springs, Tenn	do	26.1
Aug. 30	do	do	do	6.2
Aug. 24	Little Cove Creek	do	do	2.5
Do	West Fork of Little Pigeon River.	do	do	95.2
Aug. 25	do	Sevierville, Tenn	do	88.0
Aug. 29	do	do	do	51.5
Aug. 25	East Fork of Little Pigeon River.	do	do	178.4
Do	Middle Creek	do	do	1.0
Do	Bird Creek	Bird Creek, Tenn	do	3.0
Aug. 29	do	do	do	1.5
Aug. 25	Middle Fork of Little Pigeon River.	Richison, Tenn	do	126.8
Aug. 28	do	do	do	68.9
Aug. 27	East Fork of Little Pigeon River.	East Fork, Tenn	do	10.3
Aug. 28	do	do	do	9.1
Aug. 27	Cosby Creek	Cosby, Tenn	do	23.5
Aug. 28	do	Bison, Tenn	do	27.4
Aug. 27	Big Pigeon River	do	do	453.8

Miscellaneous discharge measurements of Hiwassee River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
July 26	Choestoe Creek	Choestoe, Ga	W. E. Hall and H. G. Stokes.		17.3
Do	Nottely River	do	do		46.8
July 27	Level Land Creek	do	do		29.5
Do	Stink Creek	Caldwell, Ga	do		22.8
Do	Town Creek	do	do		55.6
Do	Arququah Creek	do	do		18.8
Do	Wolf Creek	do	do		20.0
July 28	Butternut Creek	Blairsville, Ga	do		29.3
Do	Coosa Creek	Coosa Creek, Georgia	do		99.6
Do	Nottely River	Blairsville, Ga	do	1.60	505.1
July 30	Young Cone Creek	Near mouth, Georgia	do		81.3
Do	Ivy Log Creek	Ivy Log, Ga	do		32.7
Do	Camp Creek	Camp Creek, Georgia	do		13.7
July 31	Nottely River	Thompson's bridge, Georgia	do	1.40	462.0
Do	Moccasin Creek	Ivy Log, Ga	do		12.8
Do	Rapier Creek	Ranger, N. C	do		22.0
Do	Nottely River	do	do	1.40	500.4
Aug. 1	Brasstown Creek	Brasstown, Ga	do		94.4
Aug. 2	Long Bullet Creek	Twine, N. C	do		11.9
Do	Hog Creek	Hiwassee, Ga	do		15.0
Do	Bell Creek	do	do		20.6
Do	Hiwassee River	do	do		337.8
Aug. 3	Scataway Creek	Visage, Ga	do		3.2
Do	Hightower Creek	Osborn, Ga	do		73.0
Do	Fodder Creek	Hiwassee, Ga	do		19.0
Do	Owl Creek	do	do		12.3
Do	Mill Creek	do	do		22.3
Aug. 4	Centers Creek	Mountain Scene, Ga	do		23.9
Do	High Shoals Creek	do	do		18.5

Miscellaneous discharge measurements of Hiwassee River, etc.—Continued.

Date.	Stream	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
Aug. 17	Lost Creek	Near Reliance, Tenn	O. P. Hall	7.7
Sept. 4	do	do	do	6.5
Aug. 17	Ellis Creek	do	do	2.0
Do	Spring Creek	At mouth, Tennessee	do	6.8
Sept. 4	do	do	do	4.3
Aug. 18	Childers Creek	Near Reliance, Tenn	do	6.8
Do	Spring Creek	Springtown, Tenn	do	4.0
Do	Conasauga Creek	Mecca, Tenn	do	25.0
Sept. 3	do	Near Jalapa, Tenn	do	20.2

Miscellaneous discharge measurements of Toccoa (Okoee)[a] River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
		GEORGIA.		
1900.				*Sec.-ft.*
July 19	Weavers Creek	Near Blueridge	W. E. Hall and H. G. Stokes.	10.0
Do	Starr Creek	Near Morganton	do	13.6
Do	German Creek	do	do	13.0
Do	Wilscots Creek	Near Wilscots	do	26.0
Do	Persimmon Creek		do	8.0
July 20	Toccoa River	Dial	do	384.2
Do	Noontootly Creek	Near mouth	do	126.0
Do	Big Creek	Three miles from Noontootly Creek	do	52.0
July 23	Skeinah Creek	One mile above mouth	do	15.6
Do	Rock Creek	Near mouth	do	46.0
Do	Coopers Creek	One mile above mouth	do	102.0
July 24	Toccoa River	Gaddistown	do	102.0
Do	Suches Creek	Near Gaddistown	do	27.0
Do	Mill Creek	One mile above mouth	do	22.0
Do	Toccoa River	One-half mile above Mill Creek	do	19.6
		TENNESSEE.		
Aug. 15	Sylco Creek	At mouth	O. P. Hall	3.8
Do	Greasy Creek	do	do	11.3
Aug. 16	Okoee (Toccoa) River.	Parksville	do	734.0
Do	Bakers Creek	do	do	4.0
Sept. 4	Greasy Creek	Above mouth of Rock Creek	do	5.1
Sept. 5	Okoee (Toccoa) River.	Parksville	do	667.0

[a] After entering Tennessee the Toccoa is known as Okoee River.

OLENTANGY RIVER AT COLUMBUS, OHIO.

This station was established November 22, 1898, at the Fifth avenue bridge, Columbus. It is described in Water-Supply Paper No. 36, page 175. The observations of river heights are made under the general direction of Prof. C. N. Brown, of the Ohio State University. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 169. A number of measurements made in the latter part of 1899 were not published in the foregoing reports, and they, together with a measurement made on March 8, 1900, are given in the following list:

October 13, 1899: Gage height, 1 foot; discharge, 7 second-feet.
October 13, 1899: Gage height, 1 foot; discharge, 7 second-feet.
Octoben 14, 1899: Gage height, 1 foot; discharge, 7 second-feet.

October 20, 1899: Gage height, 1 foot; discharge, 7 second-feet.
November 17, 1899: Gage height, 1.20 feet; discharge, 44 second-feet.
December 2, 1899: Gage height, 1.10 feet; discharge, 15 second-feet.
March 8, 1900: Gage height, 5.42 feet; discharge, 5,039 second-feet.

Daily gage height, in feet, of Olentangy River at Columbus, Ohio, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	1.80	2.90	2.25	1.40	1.50	1.10	1.35	1.60	1.00	1.00	1.70
2	1.80	1.80	2.80	2.60	1.40	1.90	1.10	1.20	1.60	1.00	1.00	1.50
3	1.80	1.80	2.80	2.35	1.40	1.90	1.10	1.20	1.45	1.00	1.00	1.30
4	1.80	1.80	2.80	2.15	1.40	1.90	1.10	1.10	1.20	1.00	1.00	1.25
5	1.80	1.80	2.90	1.90	1.40	1.60	1.10	1.10	1.20	1.00	1.00	1.20
6	1.80	1.80	5.55	1.75	1.30	1.40	1.10	1.10	1.10	1.00	1.00	1.20
7	1.80	1.70	6.90	1.60	1.30	1.35	1.10	1.10	1.00	1.00	1.00	1.20
8	1.80	2.15	4.75	1.30	1.30	1.30	1.10	1.10	1.00	1.00	1.00	1.30
9	1.80	3.85	3.65	1.30	1.25	1.20	1.10	1.10	1.00	1.00	1.00	1.30
10	1.80	3.10	3.15	1.35	1.20	1.20	1.10	1.10	1.00	1.00	1.00	1.30
11	1.80	2.15	2.80	1.40	1.20	1.20	1.10	1.10	1.00	1.00	1.00	1.30
12	2.35	1.85	2.65	1.40	1.20	1.20	1.10	1.10	1.00	1.00	1.00	1.30
13	3.10	3.45	2.15	1.50	1.20	1.20	1.10	1.00	1.00	1.00	1.00	1.30
14	2.50	3.90	1.95	1.50	1.20	1.20	1.10	1.00	1.00	1.00	1.00	1.60
15	2.25	3.00	1.75	1.50	1.20	1.20	1.10	1.00	1.00	1.00	1.00	1.60
16	2.50	1.90	1.60	1.50	1.20	1.45	1.10	1.00	1.00	1.00	1.00	1.60
17	2.85	1.80	1.60	1.55	1.20	1.60	1.10	1.00	1.00	1.00	1.00	1.60
18	2.55	1.80	1.60	2.20	1.20	1.35	1.10	1.00	1.00	1.00	1.00	1.55
19	2.20	1.80	1.60	2.90	1.20	1.20	1.30	1.00	1.00	1.00	1.00	1.30
20	3.40	1.80	1.60	2.30	1.20	1.10	1.25	1.35	1.00	1.00	1.00	1.30
21	4.00	1.80	1.60	1.90	1.20	1.10	1.10	1.20	1.00	1.00	1.05	1.30
22	3.20	2.40	1.60	3.65	1.20	1.10	1.00	1.20	1.00	1.00	1.10	1.20
23	2.40	3.20	1.60	3.65	1.20	1.10	1.00	1.20	1.00	1.10	1.10	1.20
24	1.95	2.55	1.60	3.05	1.20	1.20	1.00	2.15	1.00	1.05	1.20	1.20
25	1.80	1.80	1.60	2.60	1.20	1.20	1.05	1.80	1.00	1.00	1.80	1.20
26	1.80	1.80	1.60	2.05	1.20	1.20	1.30	1.70	1.00	1.00	2.35	1.20
27	1.80	1.80	1.60	1.80	1.20	1.20	1.40	2.90	1.00	1.00	2.65	1.20
28	1.80	2.50	1.60	1.50	1.20	1.30	1.90	3.20	1.00	1.00	2.20	1.20
29	1.80	.....	1.60	1.40	1.20	1.30	1.80	3.00	1.10	1.00	1.80	1.20
30	1.80	.....	1.60	1.40	1.30	1.25	1.70	2.20	1.00	1.00	1.70	1.20
31	1.80	.....	1.70	.....	1.35	.....	1.65	1.85	.....	1.00	.....	1.20

SCIOTO RIVER AT COLUMBUS, OHIO.

This station was established November 22, 1898, at the Grandview avenue bridge, Columbus. It is described in Water-Supply Paper No. 36, page 176. The observations are made under the general direction of Prof. C. N. Brown, of the Ohio State University. Measurements for the year 1899 will be found in the Twenty-first Annual Report, Part IV, page 170. A number of measurements made in the latter part of 1899 were not published in the foregoing reports, and they, together with the measurements made in 1900, are given in the following table:

Discharge measurements of Scioto River at Columbus, Ohio.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 13, 1899	9.10	14	Dec. 2, 1899	9.40	43
Oct. 14, 1899	9.10	13	Jan. 18, 1900	11.90	1,328
Oct. 20, 1899	9.20	14	Feb. 15, 1900	12.90	2,391
Nov. 17, 1899	9.30	33	Mar. 7, 1900	17.37	8,581
Nov. 30, 1899	9.30	37			

Daily gage height, in feet, of Scioto River at Columbus, Ohio, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.75	10.45	12.55	12.15	10.20	9.60	9.40	9.90	9.45	9.25	9.15	10.60
2	9.70	10.40	13.00	12.70	10.15	9.60	9.40	9.60	9.30	9.20	9.15	10.35
3	9.65	10.35	12.60	12.90	10.10	9.70	9.30	9.45	9.30	9.20	9.10	10.15
4	9.50	10.30	12.60	12.40	10.05	9.90	9.30	9.30	9.20	9.30	9.20	10.05
5	9.50	10.30	12.65	11.85	10.00	9.95	9.20	9.25	9.20	9.20	9.10	9.95
6	9.45	10.30	16.65	11.35	9.95	10.00	9.20	9.10	9.10	9.15	9.15	9.85
7	9.50	10.35	17.50	11.10	9.90	9.95	9.20	9.20	9.20	9.00	9.20	9.80
8	9.55	11.50	16.05	10.85	9.90	9.90	9.20	9.10	9.15	9.00	9.20	9.80
9	9.60	14.00	15.80	10.65	9.90	9.80	9.20	9.15	9.10	9.20	9.05	9.85
10	9.60	13.25	15.15	10.50	9.80	10.20	9.10	9.25	9.10	9.20	9.10	9.90
11	9.70	12.75	14.40	10.40	9.90	10.45	9.10	9.10	9.00	9.20	9.10	9.75
12	9.75	12.15	13.60	10.40	9.90	10.30	9.10	9.00	9.00	9.40	9.10	9.65
13	11.30	13.55	12.95	10.60	9.90	10.05	9.10	9.00	8.95	9.65	9.15	9.65
14	11.40	13.75	12.30	10.95	9.80	9.75	9.15	8.90	8.90	9.50	9.20	9.45
15	11.35	12.95	11.80	10.90	9.70	9.55	9.10	9.00	8.95	9.35	9.20	9.40
16	11.45	12.50	11.40	10.80	9.70	9.45	9.10	9.25	9.00	9.30	9.20	9.40
17	12.15	11.45	10.90	10.75	9.70	9.45	9.20	9.15	9.00	9.25	9.20	9.40
18	11.95	10.95	10.90	11.80	9.75	9.60	9.10	9.05	9.20	9.20	9.20	9.40
19	11.75	11.25	11.00	12.65	9.65	9.50	9.05	8.90	9.00	9.15	9.20	9.40
20	13.35	10.85	11.15	12.20	9.50	9.45	9.45	9.55	8.90	9.10	9.25	9.35
21	15.25	10.75	11.10	11.65	9.60	9.40	9.30	9.65	8.80	8.10	9.30	9.30
22	14.20	11.90	10.85	12.50	9.60	9.40	9.20	9.50	8.80	9.10	9.30	9.35
23	13.55	12.65	10.70	12.15	9.60	9.30	9.10	9.30	8.70	9.20	9.80	9.40
24	13.15	13.05	10.60	11.90	9.55	9.00	10.15	9.80	8.75	9.20	10.15	9.40
25	12.35	12.30	10.60	11.60	9.50	9.00	9.40	10.05	8.85	9.20	10.65	9.40
26	11.70	12.85	10.80	11.15	9.50	9.05	9.15	10.30	8.90	9.15	11.70	9.35
27	11.10	12.95	10.80	10.80	9.50	9.10	9.05	10.25	8.90	9.00	11.55	9.30
28	10.70	12.65	10.75	10.55	9.50	9.25	9.10	10.05	8.90	9.05	11.50	9.30
29	10.65	.....	10.80	10.45	9.50	9.50	9.10	9.95	9.05	9.05	11.40	9.35
30	10.50	.....	10.90	10.35	9.50	9.35	10.40	9.80	9.30	9.00	11.10	9.35
31	10.85	.....	10.80	.....	9.50	.....	9.90	9.70	.....	9.10	.....	9.35

MAUMEE RIVER NEAR WATERVILLE, OHIO.

This station was established on November 19, 1898, by H. A. Pressey and B. H. Flynn. It is located at the highway bridge near Waterville, the gagings being made on the downstream side. It is described in Water-Supply Paper No. 36, pages 178 and 179, where will also be found the results of the discharge measurements made during 1899. During 1900 the following measurements were made by B. H. Flynn:

July 26: Gage height, 3.30 feet; discharge, 2,143 second-feet.

November 24: Gage height, 4.85 feet; discharge, 6,784 second-feet.

Daily gage height, in feet, of Maumee River near Waterville, Ohio, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	3.70	3.60	5.40	3.55	3.80	2.70	3.30	2.45	2.10	2.20	4.35
2	4.25	3.60	3.50	5.40	3.30	4.05	2.60	3.25	2.50	2.20	2.20	4.70
3	4.45	3.60	3.55	5.55	3.30	4.45	2.65	3.10	2.35	2.30	2.30	4.45
4	4.50	3.85	3.80	5.60	2.90	4.45	2.75	2.90	2.25	2.20	2.35	4.25
5	4.50	4.05	4.35	5.75	2.80	4.15	2.80	2.80	2.20	2.25	2.40	4.05
6	4.70	4.25	4.75	5.90	2.80	3.90	2.80	2.70	2.10	2.15	2.55	3.80
7	4.35	4.40	5.35	5.50	2.90	3.40	2.50	2.50	2.20	2.15	2.55	3.75
8	3.90	4.80	5.95	4.90	3.05	3.30	3.20	2.40	2.20	2.10	2.40	3.45
9	3.50	5.55	7.90	4.25	3.10	3.50	3.80	2.40	2.15	2.20	2.35	3.55
10	3.05	6.60	11.40	3.85	3.00	3.70	4.25	2.65	2.20	2.20	2.30	3.10
11	2.90	7.05	11.80	3.55	2.90	3.80	4.30	2.75	2.20	2.20	2.30	3.00
12	3.35	6.65	10.10	3.60	2.70	4.35	4.05	2.45	2.10	2.35	2.25	3.00
13	3.50	6.25	8.60	3.95	2.70	4.60	3.65	2.30	2.15	2.40	2.20	3.00
14	3.50	6.55	7.85	4.00	2.70	4.35	3.60	2.30	2.10	2.50	2.25	3.20
15	3.55	6.40	6.80	4.20	2.80	4.00	3.50	2.20	2.10	2.40	2.30	2.95
16	3.40	6.75	6.10	4.35	2.65	3.90	3.40	2.20	2.10	2.35	2.35	2.85
17	3.30	6.05	6.00	4.60	2.60	3.55	3.35	2.10	2.10	2.30	2.35	2.80
18	3.20	4.80	5.65	5.00	2.50	3.50	3.70	2.10	2.10	2.20	2.45	2.70
19	3.55	3.40	6.80	5.35	2.60	3.30	3.60	2.10	2.10	2.10	2.65	2.65
20	4.05	3.35	6.75	5.05	2.65	3.20	3.50	2.10	2.10	2.15	3.45	2.55
21	4.80	3.50	6.55	5.00	2.65	3.00	3.65	2.10	2.10	2.15	4.15	2.50
22	5.05	3.50	6.70	5.75	2.50	3.00	3.80	2.25	2.10	2.10	4.80	2.50
23	5.30	3.60	6.70	6.10	2.55	3.35	3.75	2.65	2.10	2.20	5.25	2.50
24	5.00	3.85	6.85	6.00	2.50	3.85	3.30	3.00	2.10	2.20	5.35	2.50
25	5.20	4.05	6.65	5.70	2.50	4.50	3.10	3.20	2.10	2.20	5.40	2.35
26	5.10	4.45	6.40	5.25	2.45	4.55	3.30	3.30	2.10	2.20	5.30	2.40
27	4.65	4.10	6.30	4.85	2.40	4.15	3.15	3.15	2.10	2.20	5.25	2.70
28	4.35	3.85	5.90	4.20	2.45	3.65	2.95	2.75	2.10	2.20	4.95	2.75
29	4.00	.....	5.35	3.90	2.60	3.15	2.90	2.70	2.10	2.20	4.55	2.55
30	3.60	.....	5.00	3.80	3.10	2.75	2.75	2.45	2.10	2.20	4.20	2.70
31	3.60	.....	5.25	.....	3.70	.....	3.15	2.40	.....	2.20	.....	2.70

SANDUSKY RIVER NEAR MEXICO, OHIO.

This station was established November 17, 1898, at the highway bridge near Mexico, about 40 miles above Fremont, Ohio. It was abandoned November 17, 1900. Only one measurement was made in 1899, when, at a gage height of 5.40 feet, the discharge was 1,386 second-feet. During 1900 the following measurements were made by B. H. Flynn:

July 25: Gage height, 1.75 feet; discharge, 133 second-feet.
November 22: Gage height, 1.80 feet; discharge, 225 second-feet.

Daily gage height, in feet, of Sandusky River near Mexico, Ohio, for 1900.

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.5	2.0	4.4	3.2	1.9	1.9	1.6	2.0	1.7	1.3	0.9
2	1.5	1.9	6.4	4.6	1.8	2.1	1.5	1.9	1.6	1.4	.8
3	1.4	1.7	6.3	5.0	1.8	2.7	1.4	1.7	1.5	1.6	.8
4	1.3	1.8	6.3	4.3	1.8	2.4	1.3	1.6	1.4	1.6	.8
5	1.2	1.9	6.8	4.0	1.7	2.1	1.4	1.4	1.3	1.5	1.0
6	1.1	1.9	9.6	3.4	1.6	1.9	1.5	1.3	1.3	1.5	.9
7	1.1	1.8	15.5	3.0	1.6	2.0	1.3	1.1	1.1	1.5	1.0
8	1.0	4.2	15.3	2.8	1.6	2.2	1.2	1.1	1.2	2.2	1.0
9	1.0	7.7	14.5	2.5	1.7	2.1	1.3	1.0	1.2	2.1	1.0
10	.9	7.6	10.9	2.3	1.6	2.1	1.2	1.0	1.3	1.9	.9
11	2.3	5.3	9.1	2.2	1.7	2.1	1.2	1.0	1.4	1.8	1.0
12	3.5	3.7	7.4	2.7	1.7	1.9	1.1	.7	1.7	1.7	1.0
13	4.2	5.6	5.5	3.4	1.7	1.8	1.0	.9	1.5	1.6	1.1
14	4.0	8.3	4.8	3.3	1.6	1.7	1.0	.8	1.4	1.5	1.0
15	4.3	7.3	4.0	3.3	1.5	1.6	.9	.7	1.3	1.5	.9
16	4.8	4.5	3.6	2.9	1.5	1.6	1.0	1.1	1.1	1.4	.9
17	5.7	3.9	3.1	2.7	1.4	1.5	.9	1.3	1.0	1.3	(a)
18	5.2	3.7	2.8	4.3	1.4	1.5	.8	1.5	1.0	1.3	.....
19	4.2	3.2	2.8	5.3	1.4	1.5	.8	1.5	1.0	1.2	.....
20	3.7	2.7	2.7	4.9	1.4	1.5	1.0	1.6	1.0	1.1	.....
21	7.9	2.4	2.6	3.6	1.3	1.6	.9	3.3	1.1	1.1	.....
22	7.8	3.4	2.3	3.3	1.2	1.6	.9	2.9	1.2	1.1	.....
23	6.1	3.7	2.4	4.0	1.3	1.6	.8	2.5	1.1	1.1	.....
24	4.7	4.6	2.3	4.5	1.2	1.5	.8	5.0	1.1	1.1	.....
25	3.9	4.2	2.2	4.0	1.2	1.5	1.3	5.9	1.0	1.2	.....
26	3.1	4.1	2.3	3.3	1.1	1.6	2.6	4.6	.8	1.2	.....
27	2.8	4.0	2.7	2.6	1.1	1.5	2.5	4.1	.8	1.1	.....
28	2.6	3.9	2.7	2.3	1.4	1.6	2.4	5.2	.7	1.0	.....
29	2.3	.....	2.8	2.0	1.5	1.9	2.0	4.8	.6	1.0	.....
30	2.0	.....	2.9	1.9	1.6	1.7	1.8	2.5	.9	1.0	.....
31	2.1	.....	2.8	.....	1.7	.....	1.9	2.0	.....	.9	.....

a Gage destroyed.

SANDUSKY RIVER AT FREMONT, OHIO.

This station, which was established November 18, 1898, by H. A. Pressey and B. H. Flynn, is at the bridge of the Lake Shore Railroad at Fremont. It is described in Water-Supply Paper No. 36, page 181. One measurement was made in 1899—gage height, 2.32 feet; discharge, 1,784 second-feet. The following measurements were made during 1900:

July 26: Gage height, 2.75 feet; discharge, 2,316 second-feet.
November 23: Gage height, 1.60 feet; discharge, 463 second-feet.

Daily gage height, in feet, of Sandusky River at Fremont, Ohio, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.95	0.65	1.95	1.20	0.60	1.50	0.85	1.40	1.00	1.10	1.00	1.75
2	.95	.65	2.70	1.70	.50	1.60	.85	1.30	.95	1.20	1.05	1.70
3	.95	.60	2.75	1.70	.40	1.65	.85	1.20	.95	1.10	.90	1.60
4	.90	.65	2.85	1.60	.40	1.70	.80	1.10	1.00	1.05	.80	1.35
5	.90	.65	2.90	1.60	.40	1.60	.75	.90	1.50	1.10	.85	1.30
6	.90	.75	4.65	1.50	.30	1.50	.65	.80	1.65	1.20	.80	1.35
7	.90	.75	6.45	1.20	.30	1.60	.70	.80	1.65	1.20	.85	1.20
8	.90	2.35	6.90	1.00	.30	1.60	.85	.80	1.65	1.10	.80	1.40
9	.90	3.30	5.70	.90	.35	1.50	.95	.90	1.75	1.20	.85	1.30
10	.90	2.80	5.30	.80	.40	1.50	.95	.85	1.70	1.15	.90	1.25
11	.95	2.15	3.55	.90	.40	1.60	.90	.65	1.70	1.10	.85	1.20
12	1.05	1.45	2.35	1.35	.30	1.50	.75	.60	1.65	1.05	.85	1.15
13	1.40	3.30	1.65	1.50	.30	1.40	.75	.75	1.65	1.05	.75	1.10
14	1.95	3.35	1.55	1.40	.30	1.50	.65	.75	1.70	.90	.80	1.05
15	2.00	2.70	1.80	1.30	.30	1.45	.50	.80	1.65	.85	.75	1.00
16	2.15	1.85	1.40	1.20	.20	1.20	.60	.75	1.75	.80	.70	1.15
17	2.15	1.15	1.20	1.30	.25	1.20	.50	.75	1.60	.95	.80	1.20
18	2.05	.80	1.20	2.15	.30	1.20	.60	1.10	1.70	1.00	.75	1.15
19	1.75	.95	1.40	2.20	.20	1.20	.55	1.05	1.65	.85	.80	1.10
20	2.60	.85	1.30	1.80	.20	1.10	.40	1.15	1.75	.80	1.10	1.00
21	3.20	.85	1.10	1.60	.20	1.10	.40	2.75	1.80	.90	1.50	1.00
22	2.95	1.35	1.10	1.45	.10	1.20	.40	2.55	1.75	.95	1.70	1.05
23	2.40	1.50	1.00	1.85	.25	1.20	.90	2.20	1.60	1.10	1.80	1.10
24	1.85	1.55	.90	1.95	.25	1.10	1.05	2.75	1.40	1.00	1.85	1.00
25	1.55	1.60	.90	1.75	1.10	1.10	1.70	3.75	1.25	1.05	2.10	1.05
26	1.35	1.70	.90	1.35	1.30	1.00	2.35	3.05	1.10	1.10	2.30	1.15
27	1.25	1.65	.90	1.05	1.30	.90	1.75	2.80	1.00	1.05	2.60	1.15
28	.85	1.80	1.10	.90	1.40	.95	1.70	2.00	1.10	1.00	2.20	1.10
29	.70	.....	1.10	.70	1.40	.90	1.50	1.50	1.00	.90	2.00	1.00
30	.70	.....	1.00	.70	1.40	.80	1.50	1.45	1.00	.85	1.90	1.00
31	.70	.....	1.00	.....	1.40	.....	1.50	1.00	.....	1.00	.....	.90

SENECA RIVER AT BALDWINSVILLE, NEW YORK.

Records of the stations on the New York streams which belong to the coast drainage will be found in Water-Supply Paper No. 47, pages 42 to 80. A number of the streams of that State on which stations have been established belong to the Great Lakes drainage, and following the geographic arrangement which has been determined upon for the publication of the records contained in these reports, the records for these stations are inserted on this and the following pages. The methods employed in the gaging of these streams is discussed on pages 37 to 41 of Water-Supply Paper No. 47, where will also be found a list of the gaging stations in New York State, a table of the current-meter measurements made during 1900, a table of the drainage areas, and other interesting information.

The gaging station on Seneca River at Baldwinsville is described in Water-Supply Paper No. 36, page 183. This river drains the central lake region of New York. The outlets of Otisco, Skaneateles, and Owasco lakes are crossed by Erie Canal, and a portion of their flow is intercepted for water-supply purposes. Water from Lake Erie feeds the main canal as far as Port Byron. Some of this water is discharged into Seneca River, and thence is delivered into Lake Ontario.

The upper reaches of Seneca River are canalized, forming the Cayuga and Seneca canals, while dams on the lower portion admit of slack-water navigation, forming a part of Oswego Canal. During the summer but little water flows over the dam at Baldwinsville. In times of

low water the mills are allowed to run a certain number of hours during the day, or until the supply accumulated in the pond above the dam is drawn down to a certain level. The water is diverted through three power canals, and is conducted to the water wheels by means of short lateral channels. The loss through leakage of wheel gates, flumes, and penstocks is considerable.

The following current-meter measurements were made at Baldwinsville:

	Second-feet.
June 11, 1900:	
Amos race	193.5
Oswego Canal	504.5
Main stream at railroad bridge[1]	1,183.0
Total flow	1,881.0
September 11, 1900 (no water flowing over dam):	
South Side Canal	475.0
Oswego Canal	317.0
Amos race	127.0
Total flow	919.0

The Baldwinsville record shows a relatively low run-off for this stream. The 1900 record is withheld for the present, additional measurements to determine leakage, etc., being needed.

CHITTENANGO CREEK AT BRIDGEPORT, NEW YORK.

This station is described in Water-Supply Paper No. 36, page 184. A current-meter measurement was made at a highway bridge below the inflow of Butternut Creek, near Bridgeport, on June 16, 1900, and the total flow of Chittenango Creek at that point was found to be 95 second-feet. The stage of the stream, as shown by the record kept at Bridgeport, was uniform for several days. The mean flow, as computed from the gage readings, was 95 second-feet for June 15 and 16. There is no opportunity to measure separately the discharge through the turbines or the leakage of the dam at this station, and an allowance of 15 second-feet has been made for the leakage of the dam and the dike leading to the old sawmill. The sawmill, situated on the left side of the stream, runs very irregularly. The water wheels are old, and the penstocks leak considerably. On June 16 a current-meter measurement was made in the headrace leading to the sawmill. The water wheels were running, and the flow was found to be 14.4 second-feet.

The relatively low run-off from the watershed of Chittenango Creek, as shown in the accompanying tables, may be attributed to the diversion of a portion of the flow to supply the summit level of Erie Canal.

State dams are located on the main stream at Chittenango, and on its two tributaries, Limestone Creek and Butternut Creek. Cazenovia Lake, Erieville, De Ruyter, and Jamesville reservoirs impound stor-

[1] Including South Side Canal.

age, by which the flow is regulated to some extent. Water is also diverted from Tioghnioga River, entering the Orville feeder through Limestone Creek.

Additional information in regard to this creek will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily discharge, in second-feet, of Chittenango Creek at Bridgeport, New York, for 1898.

[Drainage area, 307 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	180	562	427	18	a 53	284	500	a 605
2	.....	a 205	559	360	19	119	297	506	678
3	.....	171	434	348	20	139	320	a 675	669
4	(a)	172	358	a 385	21	117	269	728	793
5	.....	156	379	471	22	111	463	623	1,155
6	.....	309	a 385	414	23	115	a 465	593	1,293
7	.....	235	331	404	24	185	487	569	1,401
8	.....	204	359	320	25	a 85	472	490	a 1,075
9	.....	a 130	386	261	26	142	352	442	857
10	.....	165	474	265	27	149	867	a 465	726
11	(a)	194	1,339	a 465	28	214	972	523	541
12	.....	196	1,571	434	29	154	661	413	480
13	.....	197	a 1,265	454	30	198	a 565	421	630
14	.....	181	921	442	31	.....	519	.....	630
15	.....	354	790	450					
16	82	a 335	694	472	Mean	129	344	612	597
17	116	299	615	619					

a Sunday.

Daily discharge, in second-feet, of Chittenango Creek at Bridgeport, New York, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 515	520	632	837	447	426	116	84	81	a 75	60	113
2	571	484	473	a 795	357	346	a 55	79	49	90	145	127
3	636	440	385	752	310	234	97	169	a 45	91	145	a 143
4	737	465	520	861	172	a 105	113	126	133	90	160	159
5	1,067	a 385	a 1,260	866	172	184	132	134	81	80	a 165	149
6	1,310	356	1,331	864	157	229	99	a 70	76	141	228	151
7	1,282	342	1,475	857	a 95	229	123	125	74	89	128	166
8	a 1,135	465	1,069	1,420	172	244	132	125	96	a 45	120	179
9	724	385	860	a 1,675	172	192	a 45	134	96	107	108	155
10	486	385	852	1,369	227	147	82	79	a 15	117	65	a 168
11	473	385	659	1,306	237	a 70	262	62	71	101	46	181
12	623	a 385	a 565	1,274	172	169	271	44	96	101	a 35	211
13	849	538	1,196	1,597	172	192	162	a 15	92	85	72	326
14	738	524	1,061	1,737	a 165	182	169	141	56	72	57	395
15	a 1,260	462	970	1,614	180	109	99	125	88	a 15	65	395
16	1,280	362	665	a 1,405	174	184	a 70	103	79	84	60	374
17	1,101	449	634	1,339	250	192	101	87	a 25	30	88	a 355
18	632	354	526	1,221	310	a 70	221	76	89	38	57	466
19	390	a 385	a 565	859	374	152	210	91	74	38	a 25	706
20	395	541	736	861	374	84	204	a 25	96	45	83	588
21	389	444	766	629	a 385	92	152	120	117	47	70	298
22	a 385	619	962	447	281	100	117	109	39	a 15	78	304
23	399	950	1,061	a 165	265	124	a 70	96	84	60	100	254
24	372	1,074	1,345	627	252	134	102	.....	a 25	68	102	a 200
25	311	1,314	1,061	527	197	a 70	102	.....	67	43	110	139
26	362	a 1,015	a 885	456	195	141	122	.....	49	57	a 25	238
27	308	645	626	331	227	109	110	(a)	112	48	109	261
28	332	755	760	279	a 225	109	88	.....	119	25	133	201
29	a 385	.....	1,075	359	312	84	109	56	96	a 20	114	249
30	448	.....	1,360	a 295	333	91	a 45	96	79	65	105	244
31	637	.....	1,360	.....	229	.....	141	112	.....	65	.....	a 240
Mean	662	551	893	921	245	161	123	96	76	64	95	281

a Sunday.

Daily discharge, in second-feet, of Chittenango Creek at Bridgeport, New York, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	161	467	774	a 1,230	266	106	a 38	107	91	67	108	a 608
2	247	581	671	1,394	268	80	91	108	a 53	108	100	355
3	242	581	605	1,447	245	a 70	99	68	75	67	82	356
4	263	a 595	a 595	1,447	245	134	33	80	79	75	a 34	288
5	318	580	792	1,342	227	125	82	a 38	55	75	67	865
6	379	507	776	1,327	a 215	132	153	103	67	91	70	1,330
7	a 275	502	892	1,318	295	117	132	40	55	a 38	73	1,150
8	374	1,437	591	a 1,365	287	88	a 130	40	33	100	105	a 1,035
9	292	959	583	1,433	295	105	156	49	a 33	102	130	690
10	307	1,313	511	1,255	245	a 70	77	73	87	114	86	400
11	307	a 1,115	a 425	1,072	237	116	88	65	60	115	a 34	330
12	302	771	463	853	218	108	63	a 37	72	136	102	335
13	373	1,187	441	667	a 165	67	66	38	37	72	87	480
14	a 275	1,700	383	675	247	96	a 80	120	57	a 42	106	456
15	373	1,445	367	a 595	259	95	42	89	65	98	98	a 452
16	422	1,188	383	544	283	95	96	92	a 15	94	106	425
17	504	985	375	667	268	a 70	160	83	70	89	105	497
18	599	a 275	a 355	620	280	117	136	96	62	63	a 45	538
19	971	187	603	1,703	237	73	101	a 53	53	77	153	421
20	1,540	189	589	801	a 215	107	136	63	111	57	169	423
21	a 1,485	242	603	880	222	92	134	83	70	a 42	136	431
22	1,445	987	788	a 785	166	69	a 105	66	117	86	139	a 358
23	1,195	992	782	860	171	78	129	124	a 53	58	111	378
24	1,074	1,005	1,003	770	136	a 43	100	44	79	100	113	844
25	422	a 790	a 1,115	577	118	116	101	92	62	96	a 45	1,231
26	429	706	788	436	98	81	252	a 38	84	94	1,255	452
27	764	591	707	355	a 40	73	172	75	99	75	1,953	606
28	a 790	591	982	268	150	78	117	95	117	a 33	1,835	618
29	522	.....	1,090	a 275	92	133	a 105	86	108	75	1,272	a 442
30	372	.....	1,221	370	117	71	124	70	a 33	90	1,105	275
31	372	.....	1,351	.....	90	.....	133	66	.....	85	.....	347
Mean	561	725	697	911	207	93	110	73	68	81	327	562

a Sunday.

ONEIDA CREEK AT KENWOOD, NEW YORK.

A description of this station, which is located at the silk-mill dam in Kenwood, will be found in Water-Supply Paper No. 36, page 186. There is no leakage of the dam, and only a slight leakage of the flume and head gates, which has been taken at 2 second-feet. The flow over a wasteway near the mill is computed by means of Francis's formula. A second spillway in the canal bank near the dam has a broad, irregular crest, over which water sometimes flows. A discharge curve for this spillway has been prepared, using coefficients from the Cornell experiments for dam with a broad, flat crest.[1]

Current-meter measurements were made to check the calculated flow at Kenwood, with the following results:

		Second-feet.
June 1, 1900:		
Total flow at Oneida Castle		36.6
Flow over dam, crest gage reading 0.15 foot	19	
Flow through turbine, 11.75 feet head, one-third gate	15	
Flow over wasteway near mill	1	
Assumed leakage	2	
Total flow (computed)		37.0
September 17, 1900:		
Total flow measured in headrace		20.0
Flow through turbine, one-third gate	15	
Assumed leakage	2	
Total flow (computed)		17.0

[1] See Proc. Am. Soc. C. E., March, 1900, p. 282.

At Oneida is a State dam diverting water for the supply of the summit level of Erie Canal. No measurements of diversion to the feeder have been made. Practically the entire flow of Oneida Creek, less leakage of the dam, is taken for this purpose during the low-water season.

Additional information in regard to this creek will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily discharge, in second-feet, of Oneida Creek at Kenwood, New York, for 1898.

[Drainage area, 59 square miles.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	90	70	18	75	102	a 69
2	(a)	72	63	19	75	115	40
3	.....	70	80	20	75	a 121	60
4	.....	65	a 76	21	70	123	205
5	112	60	82	22	110	109	170
6	58	a 58	65	23	a 100	123	240
7	60	60	60	24	100	100	173
8	58	58	55	25	75	86	a 136
9	a 45	51	45	26	120	93	100
10	23	265	50	27	180	a 77	80
11	23	274	a 50	28	129	61	50
12	30	172	50	29	133	76	70
13	27	a 140	45	30	a 100	64	101
14	51	119	50	31	100	.....	101
15	110	123	55				
16	a 100	106	101	Mean	83	105	90
17	102	106	108				

a Sunday.

Daily discharge, in second-feet, of Oneida Creek at Kenwood, New York, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	a 76	50	115	122	71	46	18	a 15	144	23
2	96	65	96	a 115	60	36	a 20	21	69	29
3	108	80	115	116	60	36	20	21	56	a 25
4	210	72	112	96	59	a 35	20	21	66	27
5	300	a 59	a 157	122	54	31	30	21	a 55	29
6	160	50	22	131	55	31	34	21	44	29
7	143	50	202	166	a 48	31	21	24	40	25
8	a 114	50	168	334	53	24	41	a 18	26	33
9	95	35	128	a 260	53	24	a 40	24	26	41
10	80	37	75	214	53	24	51	24	24	a 25
11	138	100	90	196	54	a 25	26	21	26	97
12	180	a 74	a 149	496	59	26	24	24	a 27	70
13	295	56	235	416	59	26	24	24	28	70
14	273	37	157	406	a 48	26	24	24	26	91
15	a 225	47	123	341	53	51	21	a 19	22	82
16	183	42	140	a 260	60	41	a 20	25	26	73
17	135	39	144	196	61	36	31	25	26	a 30
18	101	41	133	166	68	a 30	28	25	22	30
19	75	a 40	a 157	166	66	26	26	24	a 25	97
20	65	52	198	144	91	31	26	24	28	79
21	67	160	135	136	a 80	26	24	25	24	92
22	a 57	365	157	110	82	26	25	a 25	26	80
23	55	232	254	a 102	63	31	a 25	25	24	68
24	75	147	183	96	54	31	26	25	26	a 55
25	85	99	190	91	66	a 31	21	24	24	70
26	60	a 161	a 170	110	43	31	21	25	a 25	36
27	55	232	157	110	43	31	20	24	26	39
28	42	122	123	91	a 71	24	21	25	26	27
29	a 43	.....	230	86	108	24	18	a 26	26	34
30	51	.....	183	a 93	76	21	a 20	29	26	27
31	75	.....	165	.....	59	.....	21	31	.....	a 34
Mean	117	93	157	183	62	30	25	23	33	60

a Sunday.

NOTE.—No record for August and September.

Daily discharge, in second-feet, of Oneida Creek at Kenwood, New York, for 1900.

Day.	Jan.	Mar.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	98	(a)	19	(a)	27	15	17	26	71
2	29	194	290	18	29	22	(a)	17	26	a 63
3	26	99	208	(a)	25	16	15	14	16	55
4	34	(a)	154	23	.....	16	15	14	a 16	126
5	29	135	149	20	22	(a)	15	17	16	198
6	40	191	313	17	25	16	16	17	18	160
7	(a)	223	382	23	32	13	19	(a)	16	160
8	86	140	(a)	43	(a)	15	14	14	40	138
9	54	150	220	52	42	14	(a)	35	32	a 149
10	51	199	200	(a)	31	.....	15	18	37	160
11	47	(a)	196	30	24	25	15	17	a 35	138
12	60	98	212	23	22	(a)	15	17	33	108
13	47	124	201	17	22	14	15	19	26	108
14	(a)	100	204	17	25	15	14	a 13	22	88
15	45	67	(a)	17	(a)	16	14	25	22	88
16	104	52	172	27	31	18	(a)	23	19	a 123
17	81	62	218	(a)	54	20	17	25	22	158
18	76	a 48	302	17	46	32	15	19	a 30	160
19	364	148	268	19	38	(a)	15	19	37	138
20	304	394	224	17	34	17	13	19	50	138
21	(a)	262	177	17	40	14	19	a 17	50	108
22	196	259	(a)	14	(a)	14	19	17	50	88
23	89	259	234	14	34	13	(a)	17	46	a 162
24	209	102	160	(a)	28	13	17	23	43	237
25	161	(a)	134	19	27	32	17	25	a 337	176
26	101	82	102	16	80	(a)	15	19	632	132
27	.....	154	85	19	55	28	17	17	353	126
28	a 30	128	88	14	36	31	17	(a)	232	108
29	46	128	(a)	19	(a)	28	15	19	225	96
30	45	128	61	26	31	20	a 11	19	168	a 97
31	47	118	.....	.....	28	19	17	23	.....	98
Mean	92	148	198	21	38	19	16	19	91	127

a Sunday.

NOTE.—No record for February and May.

WEST BRANCH OF FISH CREEK AT McCONNELLSVILLE, NEW YORK.

This station is described in Water-Supply Paper No. 36, page 186. During the summer the flashboards are on the dam, and Francis's formula is used in computing the flow. At other times a discharge curve derived from Cornell experiments is used. Three water wheels are in use. Two are 54-inch wheels built by the Camden Water Wheel Works, and are usually run ten hours a day, at a nearly constant gate opening.

Current-meter measurements of the discharge of one of these wheels under light and heavy load gave the following results:

June 2, 1900, discharge, 43.2 second-feet.
September 6, 1900, discharge, 51.8 second-feet.

Ten dams located on this stream furnish power to 17 mills.

Additional information in regard to this creek will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily discharge, in second-feet, of West Branch of Fish Creek at McConnellsville, New York, for 1898.

[Drainage area, 187 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	137	365	237	18	a 50	346	365	a 120
2	.....	a 50	319	245	19	98	227	365	187
3	.....	111	292	217	20	81	190	a 370	157
4	.....	121	172	a 195	21	57	172	371	190
5	.....	130	155	182	22	55	467	220	287
6	.....	137	a 120	182	23	57	a 700	216	317
7	.....	131	146	196	24	332	750	300	463
8	.....	122	138	182	25	a 360	624	329	a 390
9	.....	a 65	135	199	26	197	434	319	285
10	.....	102	557	180	27	231	1,097	a 255	285
11	.....	81	1,562	a 140	28	181	871	299	225
12	.....	87	997	199	29	181	686	251	170
13	100	124	a 700	186	30	147	a 440	172	120
14	90	134	734	212	31	.....	464	.....	120
15	96	397	434	162					
16	47	a 360	514	157	Mean	134	333	384	210
17	47	562	365	147					

a Sunday.

Daily discharge, in second-feet, of West Branch of Fish Creek at McConnellsville, New York, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	a 120	228	402	586	273	18	615	133	567	1,644	189
2	126	183	402	a 520	313	19	615	a 120	a 485	1,434	374
3	194	183	438	601	243	20	530	183	505	1,174	374
4	261	172	595	601	184	21	495	198	433	1,085	a 255
5	321	a 120	a 700	601	184	22	a 360	258	442	1,045	303
6	396	212	956	591	184	23	314	338	443	a 940	244
7	396	156	856	689	a 120	24	425	438	442	664	194
8	a 285	156	700	1,557	183	25	350	438	442	564	189
9	325	147	856	a 2,110	154	26	325	a 360	a 360	470	174
10	422	136	583	1,690	154	27	338	403	552	366	134
11	502	117	546	1,724	183	28	308	403	599	366	a 50
12	587	a 80	a 700	2,055	243	29	a 225	.....	599	364	700
13	878	99	1,178	2,440	194	30	278	.....	599	a 220	455
14	873	132	1,178	2,920	a 120	31	278	.....	599	.....	483
15	a 795	94	1,178	3,040	189						
16	787	131	972	a 2,410	189	Mean	435	206	648	1,206	239
17	786	148	782	1,720	189						

a Sunday.

Daily discharge, in second-feet, of West Branch of Fish Creek at McConnellsville, New York, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	278	96	a 52	60	48	69	157	160
2	255	78	78	60	a 10	54	144	117
3	232	a 28	78	60	20	49	133	144
4	243	70	52	58	50	65	93	122
5	243	58	52	a 10	50	65	132	257
6	a 205	70	96	50	60	64	104	201
7	225	70	80	50	60	a 34	143	169
8	165	88	a 52	50	28	39	217	150
9	185	90	78	50	a 10	39	180	117
10	185	a 52	78	58	50	59	163	118
11	185	78	78	50	50	55	110	133
12	172	70	70	a 30	60	54	107	127
13	a 105	60	70	56	60	64	107	127
14	148	68	60	168	60	a 36	132	137
15	140	78	a 10	98	58	71	112	97
16	135	86	60	61	a 10	76	101	82
17	125	a 52	60	64	60	76	86	121
18	120	72	70	48	60	46	78	112
19	106	58	60	a 19	55	86	144	95
20	a 75	78	60	30	55	71	207	58
21	104	70	60	50	196	a 60	224	50
22	104	70	a 10	50	239	106	239	28
23	96	68	60	60	a 128	116	246	31
24	96	a 28	50	55	87	218	231	31
25	86	70	64	30	87	148	196	31
26	86	70	60	a 19	66	134	330	31
27	a 38	70	76	60	66	140	355	51
28	82	70	26	134	66	a 128	223	51
29	71	70	a 36	76	50	150	187	31
30	52	68	60	50	a 58	150	179	31
31	88	.....	60	50	.....	206	.....	58
Mean	143	68	60	57	65	88	168	99

a Sunday.

OSWEGO RIVER ABOVE MINETTO, NEW YORK.

Oswego River is formed by the junction of Oneida and Seneca rivers at Three River Point. It has extensive natural storage in Oneida Lake, which covers an area of 80 square miles, and in the Finger Lakes of central New York, which it drains. Certain tributary lakes serve also as reservoirs for the water supply of the middle division of Erie Canal, and a portion of the flow is diverted for this purpose.

Oswego River has been canalized by the construction of dams, affording slack-water navigation on a part of the stream. In all there are 7 dams on the river. Surplus water at the State dams supplies power to numerous mills situated on the adjacent banks. Lateral canals and locks carry boats around the dams and connect with backwater from the next succeeding dam in each instance.

In establishing a gaging station it was impossible to measure the entire stream in a single channel, since, in order to avoid slack water from dams, it was necessary to select a site where the river is paralleled by the canal. A cable station was established September 14, 1900, 3 miles above Minetto, and below the State dam at Battle Island. A gage board was placed one-fourth mile upstream from the cable. A

weight gage is used, being suspended from a framework projecting over the water beyond the low-water margin. The position of the weight when the gage reads zero has been determined with reference to a fixed bench mark. The gage is so arranged that the readings are reversed, thus, 8.00 would be extreme low water, and when the water rises the readings are less. Morning and evening readings are taken, usually twelve hours apart, and the average of the two readings is given in the table.

A current-meter measurement was made at the cable station on September 15. The mean gage height during the measurement was 5.4 feet, and the discharge 1,677 second-feet. This does not include the diversion through Oswego Canal. The lowest water on this stream usually occurs Sundays, due to the stopping of water wheels and the consequent refilling of ponds.

In this connection reference may be made to the gaging record which was maintained by the United States Board of Engineers on Deep Waterways on Oswego River at the Oswego Falls dam from November, 1898, to May, 1899, inclusive. A description of this station will be found in Water-Supply Paper No. 36, page 188.

The drainage areas tributary to Oswego River at the different gaging stations are as follows:

Drainage areas of Oswego River.

	Square miles.
At mouth	5,002
At high dam near Oswego	5,000
At cable station	4,990
At Fulton	4,916

Additional information in regard to this river will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily gage height, in feet, of Oswego River above Minetto, New York, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	5.65	4.90	0.70	17	6.20	5.08	4.55	c 0.35
2	.....	5.65	4.90	.85	18	5.65	5.15	5.70	c .70
3	.....	5.58	5.75	.50	19	5.82	5.18	4.75	c .50
4	.....	5.55	5.75	.50	20	5.60	4.70	4.25	c .45
5	.....	5.55	5.00	c .65	21	5.52	6.15	4.25	c .40
6	.....	5.55	4.75	c 1.50	22	5.55	5.40	(a)	c .45
7	.....	6.15	4.66	c 1.50	23	5.28	4.85	(a)	c .35
8	.....	5.05	4.70	c 1.50	24	5.60	5.55	(a)	c .40
9	.....	5.30	4.80	c 1.35	25	6.10	5.55	(a)	c .15
10	.....	5.55	4.90	c 1.15	26	5.80	5.50	b 3.05	c .25
11	.....	5.35	5.50	c 1.05	27	5.65	5.50	2.25	.10
12	.....	5.20	4.50	c .85	28	5.72	6.45	1.60	.40
13	.....	5.15	4.60	c .85	29	5.70	5.05	1.15	.55
14	5.72	5.60	4.55	c .50	30	5.75	4.95	.60	.65
15	5.70	5.52	4.55	c .30	31	.....	4.80	.....	.80
16	6.50	5.30	4.60	c .30					

a No record. b New weight gage. c Used board gage.

OSWEGO RIVER AT HIGH DAM NEAR OSWEGO, NEW YORK.

A description of this station, with tables of daily gage heights, will be found in Water-Supply Paper No. 36, page 189. The dam is of masonry, with a crest 365.5 feet long. Flashboards are maintained on the dam during the greater part of the year. When flashboards are on, the flow over the dam has been computed by means of Francis's formula, with a constant coefficient of 3.33. In estimating the flow over the dam when flashboards are removed a discharge curve has been prepared, using coefficients in the weir formula derived from Cornell University experiment No. 3,[1] and taking into consideration irregularities in the profile of the crest.

A headrace at the left end of the dam diverts water to supply power to an electric-light plant and to the waterworks pumping station. There are 8 water wheels in use. A regular record of the run of the water wheels has not been kept, and the diversion for this purpose has been estimated from current-meter measurements in the headrace.

Power diversions at high dam near Oswego.

Date.	Working head on wheels.	Measured discharge.
1900.	*Feet.*	*Sec.-feet.*
June 12	13	323
September 15	14	352

Three pairs of water wheels, which were in operation when the foregoing measurements were made, are run twenty-four hours a day. Taking the average of the foregoing measurements and adding 105 second-feet for the additional pair of wheels, the diversion for water power has been estimated at 450 second-feet, as a round figure.

The flow from an auxiliary spillway in the end of the headrace has been calculated from the weir formula, using coefficients derived by Bazin for a dam having a similar crest section.

Some uncertainty attaches to the record at this station during the spring months, owing to the carrying away of the flashboards by high water at dates not definitely ascertained.

In the accompanying tables of monthly and daily mean flow no allowance has been made for diversion to Oswego Canal.

Additional information will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

[1] See Proc. Am. Soc. C. E., March, 1900, p. 274.

SALMON RIVER ABOVE PULASKI, NEW YORK.

A current-meter station was established on this stream September 5, 1900. It is located at a highway bridge 2 miles from the village of Pulaski. The stream bed is of gravel, the banks are bold, and the channel bottom is nearly flat. The gage board is attached to the center pier of the bridge, and readings are taken twice daily, at 6 a. m. and at 7 p. m. The mean of the two observations for each day is given in the table. A current-meter measurement made on September 4 showed a discharge of 103 second-feet. The mean gage reading during the measurement was 1.03 feet. There are 3 dams at Pulaski, furnishing power to 14 establishments. The total effective head obtained varies, with the stage of the stream, from 24 feet to 36 feet.

There is an undeveloped power, with a precipitous fall of 110 feet, at Salmon Falls. In November, 1898, a gaging station was established by the United States Board of Engineers on Deep Waterways 1 mile above these falls, but it was abandoned in June, 1899. A description of the station will be found in Water-Supply Paper No. 36, page 190. The drainage above the abandoned gaging station is 191 square miles, while that above the bridge station near Pulaski is 264 square miles.

Additional information regarding this river will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily gage height, in feet, of Salmon River above Pulaski, New York, for 1900.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	1.60	1.20	2.50	17	1.00	1.40	1.50	1.30
2	.....	1.50	1.20	2.30	18	1.00	1.40	1.70	1.30
3	.....	1.35	1.85	2.20	19	1.00	1.35	2.55	1.60
4	.....	1.25	1.80	2.50	20	1.00	1.35	4.20	1.95
5	1.00	1.20	1.75	2.75	21	2.15	1.30	4.30	1.40
6	1.00	1.05	1.90	2.45	22	2.25	1.25	3.65	1.45
7	1.00	1.10	1.90	2.30	23	1.75	1.25	3.10	1.60
8	1.00	1.35	2.75	2.15	24	1.65	1.45	2.45	2.25
9	1.00	1.85	2.55	1.65	25	1.55	2.00	2.50	2.50
10	1.00	1.80	2.25	1.50	26	1.35	1.95	3.50	2.40
11	.90	1.60	1.90	1.50	27	1.25	1.85	4.70	2.20
12	.90	1.50	1.90	1.40	28	1.25	1.85	3.75	2.20
13	.90	1.40	1.80	1.40	29	1.25	1.70	3.35	2.10
14	.90	1.40	1.80	1.40	30	1.45	1.75	2.55	2.20
15	.95	1.30	1.70	1.35	31	.....	1.75	.....	2.30
16	1.00	1.40	1.50	1.30					

MOOSE RIVER AT MOOSE RIVER, NEW YORK.

On June 5, 1900, a gaging station was established on this stream at Moose River, 4 miles below the McKeever railroad station. The section of the channel chosen to be spanned by a cableway has a width of 225 feet, with a nearly flat gravel bottom. A vertical gage board was attached to a pile driven out in the stream beyond the low-water margin and protected from ice and logs by a floating boom anchored upstream.

Moose River is characterized throughout its entire course by rifts

and rapids. Topographically the watershed is rocky, precipitous, and mostly timbered. The drainage area above the gaging station is 346 square miles. An area of 41 square miles in the headwaters is subject to regulation by storage, controlled by a State dam at Old Forge, at the foot of the Fulton Lakes. There are numerous undeveloped water powers on the stream, including two falls near Lyonsdale, where a head of 30 or more feet might be obtained, and another (Millers Falls) of nearly equal height below the town of Moose River. Water power is developed at 8 dams, a total fall of 225 feet being utilized, the aggregate capacity of the turbines installed being more than 7,000 horsepower.

No current-meter measurements have thus far been made. Gage readings are taken twice daily, morning and evening, and the mean of the two readings for each day is given in the accompanying table.

Additional information in regard to this river will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily gage height, in feet, of Moose River at Moose River, New York, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	0.50	0.85	0.90	0.70	1.15	17	0.92	0.80	1.20	0.70	0.75	2.05
2	.....	.60	.70	.80	.75	1.20	18	.65	.75	1.00	.65	.60	2.30
3	.....	.25	.70	.65	.80	1.05	19	.60	.85	.85	.60	.65	1.70
4	.....	.35	.60	.55	.70	.95	20	.80	.90	.60	.55	.75	3.95
5	2.00	.30	.50	.60	.60	.85	21	.95	.80	.60	.80	.75	4.45
6	1.55	.35	.55	.55	.60	1.10	22	.90	.65	.60	1.20	.70	4.10
7	1.25	.70	.60	.55	.60	1.10	23	.80	.55	.50	1.55	.70	3.70
8	1.20	.85	.55	.60	.65	2.25	24	.70	.60	.45	1.30	1.30	3.35
9	1.95	.75	.55	.65	.60	3.10	25	.80	.85	.55	1.05	2.00	3.20
10	1.55	.70	.60	.70	.60	2.50	26	.60	3.05	.65	.90	1.65	3.05
11	1.40	.65	.70	.55	.65	1.75	27	.40	1.85	1.75	.90	1.30	3.65
12	1.20	.90	.65	.55	.55	1.15	28	.30	1.20	2.00	.85	1.30	3.75
13	1.08	.90	.80	.55	.45	.95	29	.50	.90	1.35	.70	1.25	3.55
14	1.05	.80	1.80	.50	.45	.90	30	.55	.75	1.40	.80	1.25	3.20
15	.82	.75	1.75	.40	.70	1.25	31	.....	.70	.95	.....	1.30	.....
16	1.05	.70	1.25	.70	.85	1.75							

BEAVER RIVER, NEW YORK.

Beaver River rises in the western part of Hamilton County, crosses Herkimer County, and emerges from the Adirondacks at the town of Number Four, on the Lewis County line. The flow from the tributary watershed above Beaver, comprising an area of 153 square miles, or 47.5 per cent of the entire drainage area, is regulated by storage in the Beaver Flow or Stillwater, an artificial lake formed by a timber dam 16 feet high. In addition to the reservoir formed by the State dam at Beaver, there are within this region more than 50 natural lakes, including Red Horse Chain, so that a comparatively uniform flow is maintained throughout the summer season.

An examination of Beaver River with reference to facilities for gaging was made early in July, 1900. The almost continuous rapids in the upper reaches of the stream limit the desirable sites for gaging stations to the stream channel below Beaver Falls, 4 miles from its confluence with Black River at Castorland. Arrangements were

made for the establishment of a cable station, but owing to the presence of log rafts in the stream during the greater portion of the summer the record has not yet been started.

From the State dam at Beaver to the town of Number Four, a distance of 10 miles, the stream consists of numerous bowlder rapids, alternating with short stretches of smooth water. Above Beaver Lake there is a high fall, forming a descent of 60 feet within a distance of 400 or 500 feet. From the foot of Beaver Lake to Belfort, a distance of 12 miles, the stream channel continues rocky and precipitous, although the adjacent watershed is sandy and for the most part covered with timber. Eagle Falls, 2 miles below Beaver Lake, consists of a series of cascades, aggregating a descent of 75 feet. There are a number of other undeveloped water powers in this vicinity.

Water power is developed at Beaver Falls, at Croghan, and at Belfort, aggregating 4,400 horsepower, at five dams, and utilizing a fall of 133 feet. There is also an abandoned power at Tisses Falls, below Belfort, where a total head of 60 feet could be obtained. Power is developed at Belfort, under a head of 50 feet, for the generation of electricity which is transmitted to adjacent towns, a distance of 16 miles.

Rainfall and other meteorological records have been kept since January, 1889, at Number Four, in the heart of the timber-covered portion of the watershed.

Additional information regarding this river will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

BLACK RIVER AT HUNTINGTONVILLE DAM, NEAR WATERTOWN, NEW YORK.

A description of this station, including tables of daily gage heights, will be found in Water-Supply Paper No. 36, page 191. The entire flow of Black River at this point, aside from leakage and a slight diversion for the municipal water supply of Watertown, passes over the Huntingtonville dam. Two or more readings of the crest gage are taken daily, and the mean of the readings from midnight to midnight has been used in estimating the mean daily flow. In computing the flow over the dam, an allowance of 200 second-feet has been made for leakage through seams and crevices in the limestone rock underlying the dam. This amount has been arrived at from an estimate of the size of the orifices and the head on the same, when the water was drawn down in the summer of 1897.

There is no way to check direct the flow during high water immediately below the dam, but a current-meter measurement was made at Glenpark Bridge on June 6, 1900, which gave a total flow of 2,175 second-feet.

The mean daily flow for the years 1897, 1898, 1899, and 1900 is given

in the accompanying tables. It does not represent the total water-yielding capacity of the tributary drainage area, inasmuch as a portion of the flow from the headwaters is diverted to the Forestport feeder to supply Black River Canal. Storage reservoirs, to compensate water-power users, are maintained by the State of New York on Beaver and Moose rivers, the principal tributaries of Black River. Owing to flood-water storage, diversion, and the effect of mills starting and stopping irregularly, the regimen of this stream is far from natural. Measurements of the amount of diversion of Black River below Forestport reservoir have been made by Mr. E. C. Murphy, for the New York State canal survey.

The highest water observed while the record has been kept was on the morning of April 21, 1900, the reading of the crest gage being 108.41 feet, and the corresponding flow 30,150 second-feet, equivalent to a flow of 16 second-feet per square mile of tributary drainage.

This stream is of great importance as a source of water power, having 22 dams in its lower stretch of 18 miles, furnishing, in round numbers, 60,000 horsepower to 80 mills along its banks, which employ an aggregate of 3,900 persons.

Additional information will be found in Water-Supply Paper No. 47, pages 37 to 41, in a paper entitled "Methods employed in the gaging of New York streams during the year 1900."

Daily discharge, in second-feet, of Black River at Huntingtonville dam, New York, for 1897.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1	.....	1,220	5,060	8,550	3,362	978	a1,710	.....	598	6,812
2	.....	.....	5,170	a7,692	2,865	956	1,606	.....	872	5,850
3	.....	.....	5,850	6,514	2,300	1,066	1,580	.....	1,738	2,835
4	.....	.....	a6,176	5,890	2,835	a890	1,292	.....	2,610	2,455
5	.....	2,060	8,020	6,602	3,328	782	990	.....	2,362	a3,420
6	.....	2,865	8,650	6,218	a3,095	646	782	.....	1,850	4,665
7	.....	a3,220	9,590	5,970	2,579	1,066	630	.....	a1,850	5,290
8	.....	3,396	10,916	4,739	2,300	710	a362	.....	2,120	5,490
9	.....	3,600	11,540	a3,705	2,000	678	536	.....	2,150	5,770
10	.....	4,230	11,540	2,900	4,484	746	630	.....	2,800	5,850
11	.....	5,650	a10,500	2,900	6,176	a536	2,930	.....	4,374	7,428
12	.....	5,970	8,750	2,455	6,428	582	6,812	.....	4,411	a7,692
13	.....	6,602	7,340	2,515	a5,970	836	7,252	.....	4,850	7,120
14	.....	a3,260	6,856	3,029	4,411	614	5,850	1,044	a4,020	6,680
15	.....	5,650	7,120	4,592	3,362	1,110	a3,420	1,220	3,670	7,252
16	.....	5,130	7,924	a5,170	2,770	1,198	2,362	2,455	3,029	8,068
17	.....	4,300	8,850	4,665	2,424	1,110	1,710	a854	4,125	8,500
18	.....	3,950	a9,240	4,125	2,060	a1,000	2,000	1,176	5,170	8,308
19	.....	3,880	9,690	3,328	1,658	934	2,424	1,110	5,210	a6,092
20	.....	2,240	9,390	3,062	a1,460	978	1,804	956	3,950	3,420
21	.....	a8,600	9,690	2,485	2,090	1,000	1,292	854	a2,930	3,195
22	1,460	8,550	9,290	2,642	2,706	890	a1,022	800	3,362	3,195
23	1,460	10,916	8,290	a3,095	2,270	728	978	782	2,835	3,130
24	2,610	16,500	7,648	2,424	1,804	630	694	a480	2,150	2,770
25	1,850	4,250	a9,144	2,515	1,388	a480	522	956	1,850	2,393
26	3,420	12,080	11,176	3,950	1,198	1,000	566	746	3,396	a2,515
27	.....	10,760	12,640	4,776	a978	934	582	782	6,218	2,270
28	.....	a7,924	14,142	4,374	1,198	890	322	854	a9,144	2,180
29	.....	6,176	13,806	4,020	978	1,220	a1,254	710	9,890	2,060
30	.....	5,450	10,552	a3,775	934	1,940	.....	710	8,116	2,000
31	.....	5,450	.....	3,600	.....	2,000	.....	a678	.....	1,804
Mean	2,160	6,317	9,484	4,267	2,713	879	2,280	954	4,155	4,725

a Sunday.

NOTE.—No record from September 1 to October 13, inclusive.

Daily discharge, in second-feet, of Black River at Huntingtonville dam, New York, for 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,738	2,770	2,300	7,340	a4,411	2,770	1,436	1,110	1,244	1,556	3,095	2,548
2	a2,270	2,930	2,610	6,646	3,362	2,362	1,316	1,580	1,220	a1,022	2,706	2,455
3	1,940	2,835	2,300	a5,050	3,530	2,030	a872	1,132	1,110	1,088	2,610	2,455
4	2,000	2,610	2,300	3,950	3,705	1,804	800	1,292	a330	1,110	2,393	a2,240
5	2,120	2,770	2,150	3,600	3,915	a1,738	1,110	1,460	1,340	1,412	2,300	2,300
6	2,000	a2,455	a2,150	3,600	4,776	1,556	1,088	1,880	1,766	2,770	a2,210	2,240
7	1,850	2,610	2,150	3,420	4,411	1,532	1,176	a1,710	1,684	3,420	3,095	1,940
8	1,580	2,610	2,210	3,362	a3,420	1,340	1,022	1,580	2,060	2,865	2,930	1,804
9	a1,850	2,455	2,674	3,095	2,770	1,176	956	1,244	1,940	a1,910	2,930	1,658
10	1,804	2,300	3,420	a3,029	2,930	1,244	a728	1,110	1,804	1,940	2,930	1,684
11	1,804	3,195	6,386	3,029	2,455	1,484	836	1,110	a1,460	1,684	8,404	a1,532
12	1,766	3,900	12,360	2,800	1,940	a1,292	1,000	1,176	1,484	1,364	9,240	1,804
13	3,029	a8,164	a18,200	2,642	3,600	1,340	1,000	1,340	1,292	1,292	a9,144	1,804
14	4,300	7,340	23,300	2,706	3,800	1,804	978	a1,268	956	1,606	8,750	1,850
15	4,665	6,470	27,900	2,930	a3,328	2,150	1,000	630	1,000	2,706	7,472	1,850
16	a4,448	5,450	23,700	2,900	2,642	2,030	1,000	1,244	890	a3,500	6,176	1,880
17	4,265	4,484	17,850	a2,548	2,610	1,804	a956	1,000	872	4,411	4,692	2,000
18	3,880	3,950	14,800	2,240	2,362	1,532	1,000	890	a508	3,775	3,880	a1,850
19	3,530	3,600	13,750	2,548	2,150	a1,154	1,436	956	800	2,996	3,260	1,940
20	3,420	a3,362	a12,304	2,865	2,548	1,850	1,154	934	818	2,706	a2,063	2,090
21	4,300	3,775	12,804	3,775	2,865	2,150	1,220	a956	1,132	2,674	3,294	2,090
22	5,650	3,985	13,582	4,265	a2,706	2,000	1,220	818	1,044	2,963	3,294	2,548
23	a5,650	3,915	13,032	5,250	2,424	1,804	1,220	1,110	890	a4,374	3,029	4,230
24	6,176	3,600	11,280	a6,386	2,548	1,658	a934	2,150	1,460	5,480	3,394	5,610
25	5,970	3,230	9,390	7,252	2,770	1,340	1,292	2,610	a2,738	4,592	2,800	a5,450
26	5,530	2,930	8,260	8,950	2,865	a1,220	2,000	3,095	2,865	4,055	2,548	5,130
27	4,739	a2,770	a6,900	10,140	3,775	1,066	1,710	3,130	2,770	5,570	a1,658	4,310
28	3,950	3,095	6,176	9,690	4,055	1,340	1,340	a2,706	2,393	6,680	2,030	3,420
29	3,396	.....	6,302	7,780	a3,362	1,316	1,364	2,000	2,770	6,558	2,331	3,095
30	a2,900	.....	7,340	5,850	3,230	1,292	1,292	1,460	1,850	5,250	2,610	3,705
31	2,930	.....	7,924	.....	3,130	.....	a1,508	1,658	.....	3,950	.....	4,813
Mean	3,402	3,806	9,609	4,654	3,174	1,639	1,128	1,495	1,483	3,138	3,932	2,720

a Sunday.

Daily discharge, in second-feet, of Black River at Huntingtonville dam, New York, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,230	1,940	3,565	4,125	18,000	3,095	1,460	956	978	a956	2,240	1,176
2	3,985	2,090	3,260	a3,915	16,150	2,393	a1,022	1,000	1,244	956	3,420	1,198
3	3,396	2,030	3,230	3,800	14,800	2,240	1,000	1,110	a630	1,460	4,055	a1,412
4	3,600	2,000	3,328	3,565	13,694	a1,804	956	1,000	1,110	1,340	3,230	2,090
5	10,396	a2,000	a3,880	3,600	12,080	1,658	1,388	854	480	1,176	a2,900	2,060
6	9,740	2,000	5,170	3,985	9,490	1,710	1,436	a678	1,000	1,022	2,706	1,658
7	8,750	2,000	5,970	4,520	a7,516	1,658	1,580	800	890	1,022	2,393	1,460
8	a8,750	2,000	5,530	6,900	5,090	1,532	1,460	890	1,022	a678	1,850	1,220
9	7,972	2,000	5,090	a8,116	4,125	1,340	a1,176	1,000	1,066	1,044	1,832	1,198
10	6,812	1,984	4,592	8,308	3,705	1,532	1,880	854	a1,022	854	1,460	a1,110
11	5,450	1,850	4,125	8,950	3,362	a1,220	1,340	728	1,220	956	1,412	1,658
12	4,484	a1,984	a5,210	10,656	3,705	1,532	2,150	678	678	800	a1,066	4,850
13	4,055	2,240	8,164	11,072	3,880	1,340	1,738	a710	1,340	818	1,436	8,404
14	3,950	2,240	8,020	12,136	a3,260	1,340	1,532	728	630	818	1,132	8,404
15	a4,702	2,240	7,736	13,694	2,930	1,132	1,412	1,044	694	a818	1,220	7,928
16	5,810	2,150	6,900	a13,806	3,029	1,460	a1,022	1,110	1,176	694	1,364	5,650
17	5,890	2,210	6,680	14,086	3,095	1,460	934	1,066	a764	1,000	1,460	a2,706
18	5,450	1,984	5,850	14,086	3,705	a1,460	1,000	1,606	1,220	978	1,460	3,294
19	5,250	a1,850	a5,250	14,700	3,029	1,658	1,292	1,000	1,176	1,044	a1,066	4,702
20	3,095	2,000	4,629	17,400	3,775	1,340	956	a710	710	1,088	1,110	5,450
21	3,740	2,090	4,665	20,900	a4,484	1,220	956	522	800	854	1,244	6,470
22	a3,362	2,362	4,629	24,400	4,337	1,220	1,000	1,000	1,066	a522	1,176	6,680
23	3,195	2,963	4,665	a24,950	3,775	1,220	a978	890	710	1,000	1,066	5,050
24	2,930	3,465	5,050	25,000	3,500	1,340	1,220	854	a630	956	1,198	a4,337
25	2,770	3,420	4,930	24,850	2,900	a1,268	1,340	1,244	1,198	1,066	1,110	4,300
26	2,900	a3,095	a4,776	24,950	2,424	1,292	1,132	1,110	1,110	1,110	a782	2,930
27	2,610	3,420	4,592	24,300	2,485	1,532	1,044	a854	1,198	1,110	1,088	2,548
28	2,393	3,530	4,230	23,450	a2,393	1,340	1,088	872	1,198	1,110	1,132	2,300
29	a2,000	.....	4,090	22,250	2,362	1,176	836	890	1,198	a1,066	1,066	2,240
30	2,300	.....	4,592	a20,350	3,362	1,340	a550	1,000	1,532	1,292	912	2,240
31	2,120	.....	4,195	.....	3,420	.....	458	956	.....	1,940	.....	a1,804
Mean	4,712	2,326	5,051	13,894	5,609	1,528	1,205	897	990	1,018	1,652	3,501

a Sunday.

Daily discharge, in second-feet, of Black River at Huntingtonville dam, New York, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,766	2,300	2,865	a3,800	11,280	2,000	a978	1,340	1,240	780	1,610	9,900
2	1,710	2,300	2,610	4,265	11,020	1,710	978	1,110	a1,200	1,440	1,535	8,000
3	1,710	2,240	2,579	5,370	10,812	2,000	1,000	1,220	1,010	1,200	1,440	6,400
4	1,710	a2,060	a2,770	6,050	9,740	a2,060	854	1,000	(b)	960	1,120	5,650
5	1,710	2,060	2,770	7,384	9,000	2,200	1,000	a854	.....	1,120	1,370	5,700
6	1,710	2,150	2,930	7,560	a7,780	2,000	1,110	694	.....	1,200	1,120	5,650
7	a1,710	2,200	2,865	9,740	6,900	2,150	1,110	1,000	.....	a780	1,245	5,700
8	2,300	2,150	2,674	a12,192	6,050	2,424	a764	1,154	.....	1,010	.....	4,900
9	2,362	4,850	2,930	10,760	5,650	2,579	1,268	690	(a)	960	.....	4,180
10	2,362	5,850	2,930	10,760	6,602	2,485	1,244	820	.....	1,240	.....	3,300
11	2,240	a5,770	a2,674	10,240	7,560	a2,610	1,340	780	760	980	2,990	3,460
12	2,150	5,250	2,930	10,344	6,050	2,000	1,268	a1,610	740	870	2,895	3,145
13	2,270	6,344	2,674	9,490	a5,770	2,060	1,532	1,010	780	780	2,475	2,990
14	a1,710	11,458	2,610	7,340	5,650	1,766	1,580	1,490	780	a580	2,120	2,780
15	1,940	12,304	2,610	a6,386	5,250	1,580	a1,198	1,730	740	820	2,250	3,080
16	1,850	14,060	2,610	7,208	5,250	1,580	1,460	1,680	a390	780	1,485	2,200
17	1,580	13,470	2,610	9,096	5,650	1,268	1,220	1,535	740	1,010	1,780	2,780
18	1,710	a11,280	a2,548	10,604	5,530	a1,154	1,268	1,240	1,120	1,050	1,680	2,255
19	1,940	9,590	2,610	20,100	5,250	1,460	1,340	a2,120	1,100	1,050	3,900	2,595
20	2,930	7,924	2,610	27,050	a5,170	1,364	1,766	1,010	1,120	1,050	8,600	2,830
21	a5,930	5,770	2,610	30,000	4,930	1,044	1,580	1,240	980	a740	9,175	2,780
22	6,260	5,130	3,420	a29,500	4,374	1,044	a1,460	1,200	980	960	8,900	2,535
23	5,850	5,130	4,020	27,700	4,265	1,110	1,556	810	a1,055	1,240	8,600	2,535
24	5,770	4,850	3,915	25,200	3,705	1,110	1,766	480	1,240	1,440	7,820	3,640
25	4,850	a4,230	a3,600	23,300	3,161	a1,176	1,340	810	1,780	1,980	6,280	5,450
26	4,125	3,775	3,600	21,750	3,420	1,340	1,220	a500	1,490	2,340	6,680	5,280
27	3,670	3,095	3,260	20,000	a2,706	978	2,150	780	1,295	2,120	9,900	4,900
28	a3,420	2,996	3,260	17,050	2,485	836	1,850	780	1,200	a1,605	12,250	4,220
29	3,195	.....	3,260	a14,800	2,150	764	a1,316	1,780	915	1,860	13,900	3,810
30	2,865	.....	3,260	12,752	2,000	1,044	1,268	1,440	a800	1,885	12,250	.....
31	2,548	.....	3,465	.....	1,904	.....	1,176	1,240	.....	1,935	.....	.....
Mean	2,834	5,734	2,970	13,926	5,711	1,630	1,321	1,134	1,020	1,218	5,014	4,230

a Sunday. *b* Sluice gates open.

GRAND RIVER, MICHIGAN.[1]

This is the largest stream in the State. Its drainage basin, which includes a total area of 5,572 square miles, is situated in the central portion of the lower peninsula, and drains into Lake Michigan. It lies in the southern border of the pine belt and is for the most part cleared. Occasional tracts of forest remain, however, as, for example, Slocum's Grove, in Muskegon County, which forms a part of the drainage basin of Crockery Creek, and contains between 4,000 and 5,000 acres of hard-wood and hemlock timber, now being lumbered. The basin is overlain with glacial drift deposits, including sand, clay, overwash, gravel, and till, with outcroppings of rock at rare intervals. A stratum of limestone, said to be 52 feet thick, appears in the east side of the bed of Grand River at Grand Rapids, 100 feet above the Pearl street bridge. It dips in a northeasterly direction, at a slope of 50 feet to the mile, and does not appear in the west side canal. The watershed receives an annual rainfall varying from 25 inches in the region of the headwaters to 30 or 35 inches near the mouth of the river. From the foot of the rapids formed by the limestone ledge at Grand Rapids to the mouth of the river at Lake Michigan the flow is

[1] Report of Robert E. Horton.

very sluggish; the fall in this portion is given below, from levels run by Mr. Fred Morley, United States assistant engineer.

Fall of Grand River between Grand Rapids and its mouth.

Section.	Distance.	Fall.
	Miles.	*Feet.*
Grand Rapids to Grandville	6.0	2.85
Grandville to Lamont	11.5	2.92
Lamont to Grand Haven	21.64	0.43
Total	39.14	6.20

In the upper half of this stretch of the river the immediate banks of the stream are high, sometimes forming natural levees at elevations greater than that of the adjacent flood plain. Mr. Morley states that below Lamont bayous and low swamps are common between the river banks and the foothills bordering the valley. The valley as a whole is narrow; gravel bluffs from 50 to 60 feet high occasionally stand close to the stream. The river below Grand Rapids has been adjudged navigable, and a project has been formed for its canalization, the plan being for a waterway, with a navigable depth of 10 feet, connecting the city of Grand Rapids with Lake Michigan.

The drainage areas of the main stream and its tributaries at various points are given in the following table:

Drainage areas of Grand River and its tributaries.

Stream.	Location.	Area.
		Sq. mi.
Grand River	Above Lansing	756
Red Cedar River	Above mouth	472
Grand River	Below mouth of Red Cedar River	1,229
Do	Above Portland	1,404
Lookingglass River	Above mouth	306
Grand River	Below mouth of Lookingglass River	1,710
Do	Above Lyons	1,748
Maple River	Above Maple Rapids	459
Do	Above mouth	919
Grand River	Below mouth of Maple River	2,667
Do	At Ionia	2,818
Do	Above Lowell	2,971
Flat River	At mouth	602
Grand River	Below mouth of Flat River	3,573
Thornapple River	Above mouth	824
Grand River	Above Grand Rapids water-power dam	4,883
Do	Above mouth	5,572

The watershed is comparatively flat. The total fall of the river from the extreme headwaters to the mouth, a distance of more than 200 miles, is about 350 feet.

Fall and slope of Grand River.

Location.	Elevation above mean tide.	Approximate fall.		Approximate distance.	
		To mouth of stream.	Between points.	From mouth.	Between points.
	Feet.	*Feet.*	*Feet.*	*Miles.*	*Miles.*
Grand Haven	581.3	0.0	0.0	0	0
Grand Rapids *a*	587.5	6.2	6.2	39	39
Lowell	635.0	53.7	47.5	67	28
Ionia	640.0	58.7	5.0	83	16
Portland	710.0	128.7	70.0	106	23
Lansing	825.0	243.7	115.0	138	32
Jackson	915.0	333.7	90.0	192	54

a Foot of rapids.

The northwestern and southeastern portions of the watershed are thickly interspersed with small lakes. A considerable number of these have no surface outlets, and their drainage basins do not contribute to the run-off of the river except through ground water.

The water of Grand River is hard. Samples collected on June 20, 1899, showed the following analyses:[1]

Analyses of water from Grand River and tributary streams, in parts per million.

Stream.	Location.	Total residue.	Chlorine.	Free ammonia.	Albuminoid ammonia.	Temporary hardness.
Grand River	Grand Rapids pumping station.	281.6	4.0	0.112	0.320	240
Thornapple River	At Cascade	280.0	4.3	.094	.208	250
Muskegon River	Above Big Rapids	184.0	1.9	.052	.344	170
Bailey Creek (spring fed)		245.6	1.7	.006	.096	225

Grand River serves as a source of water supply to the city of Grand Rapids. The average daily consumption of that city for the year 1899–1900 was 13,693,499 gallons a day, equivalent to a flow of 21.3 second-feet. The population in 1900 was 87,565.[2]

In connection with proposed improvements for navigation, gaging stations have been established at various points on Grand River below Grand Rapids. All gages are set with their zeros at the Lake Michigan datum, 581.28 feet above mean tide of the New York harbor deep-sea levels. Since 1890 observations have been taken at different stages of the stream, notably during high water, with a view to determining its slope. Cross sections have also been made, and these data will, when completed, form a basis for computing the flow of the river by means of Kutter's formula.

[1] Report of Consulting Engineers to Pure Water Commissioners of the City of Grand Rapids Michigan, 1899.
[2] Report of Board of Public Works, Grand Rapids, 1900.

The results of the gage readings for the year 1891, referred to the Lake Michigan datum, are given in the following table:

Gage heights, in feet, of Grand River at various points.

Month.	Mean gage heights.				Highest observed.				Lowest observed.			
	Grand Rapids.	Grandville.	Lamont.	Grand Haven.	Grand Rapids.	Grandville.	Lamont.	Grand Haven.	Grand Rapids.	Grandville.	Lamont.	Grand Haven.
1891.												
January	8.16	4.93	1.81	−0.70	9.74	6.38	2.37	+0.42	7.19	4.08	1.27	−1.28
February	8.95	5.90	2.72	− .93	13.64	10.68	6.67	− .13	7.04	4.28	1.37	−1.68
March	11.91	9.48	5.35	− .79	16.64	14.08	8.87	− .29	8.99	6.18	2.77	−1.53
April	11.45	8.52	4.65	− .47	14.49	11.48	6.87	+ .17	8.29	5.18	2.17	−1.08
May	6.93	3.62	.92	− .35	8.19	5.08	2.17	+ .17	6.24	2.78	.37	− .90
June	6.45	2.99	.66	− .25	6.99	3.78	1.07	+ .72	5.74	2.38	.37	− .69
July	5.77	2.51	.37	− .63	6.49	3.18	.77	+ .27	5.16	2.08	.07	− .91
August	5.33	2.12	.09	− .41	6.34	3.08	.87	+ .02	4.92	1.78	− .13	− .72
September	5.60	2.51	.26	− .32	5.14	3.08	.77	+ .02	5.12	1.73	− .23	−1.29

Float measurements of the flow of Grand River were made by Mr. Morley during the low-water period of 1891, as follows:[1] July 21, 5.52 miles below Grand Rapids; August 18, 16.68 miles below Grand Rapids. Rod floats were run across the stream at intervals of 10 feet, and were timed while passing downstream a distance of 100 feet. From these measurements the minimum flow of 1891 was estimated at 981.5 second-feet, the corresponding stage on the Grand Rapids gage being 5.67 feet.

In addition to the foregoing, Mr. Morley calculated the flow at various stages, from measured slopes and sections, by means of Kutter's formula, with the following results:

Calculated flow of Grand River near Grand Rapids.

Gage height on Grand Rapids gage.	Corresponding gage height at discharge section.	Area of cross section. (A)	Wetted perimeter. (P)	Hydraulic radius— $\frac{A}{P}=R$.	Slope.	Coefficient of roughness.	Mean velocity.	Discharge.
Feet.	*Feet.*	*Square feet.*	*Lineal feet.*		*Feet per foot.*		*Feet per second.*	*Second-feet.*
5.67	2.57	1,205.5	330.0	3.653	0.000035	0.026	0.8142	981.5
7.32	4.24	1,765.4	345.5	5.109	.0000466	.026	1.2187	2,151.0
10.32	7.62	2,961.9	367.5	8.059	.0000559	.026	1.8614	5,514.0
14.32	11.54	4,365.4	392.0	11.136	.000067	.026	2.8363	12,382.0

A nearly continuous record of the stage of Grand River at the Chicago and West Michigan Railroad bridge, 1 mile below the dam in Grand Rapids, has been kept since May 26, 1897. A copy of this record has been furnished by George W. Bunker, United States assistant

[1] Report on Survey of Grand River below Grand Rapids, War Department, 1892.

engineer. The daily gage heights, referred to the Lake Michigan datum, are given in the following tables:

Daily gage height, in feet, of Grand River at Grand Rapids, Michigan, for 1897.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.5	6.5	.....	6.2	.....	6.3	6.4
2	.....	6.8	6.5	6.9	6.4	5.9	5.9	6.4
3	.....	7.2	6.5	6.9	6.6	6.0	5.8	6.4
4	.....	7.1	.....	6.7	6.4	6.0	5.9	6.4
5	.....	7.0	.....	6.7	.....	6.0	5.9	.....
6	.....	.....	6.3	6.6	.....	5.9	6.0	6.8
7	.....	7.0	6.3	6.7	6.1	5.8	.....	6.8
8	.....	6.8	6.3	.....	6.3	5.9	6.1	7.0
9	.....	7.0	5.4	6.8	6.4	5.8	.....	7.0
10	.....	7.0	5.4	6.8	6.4	.....	6.2	7.0
11	.....	6.9	.....	6.7	6.2	5.9	6.3	7.6
12	.....	6.8	6.3	.....	.....	6.0	6.6	.....
13	.....	.....	6.5	6.6	6.1	6.1	6.7	8.1
14	.....	6.6	6.8	6.4	6.2	6.3	.....	8.2
15	.....	6.6	7.3	.....	.....	6.4	6.6	8.2
16	.....	6.8	7.2	6.4	6.2	6.3	6.8	8.1
17	.....	7.3	7.0	6.4	5.9	.....	7.0	8.0
18	.....	7.0	.....	6.4	6.1	6.1	6.9	7.0
19	.....	6.9	6.7	6.4	.....	6.1	6.6	.....
20	.....	.....	6.6	6.3	6.2	5.9	6.6	7.2
21	.....	6.9	6.5	6.3	6.2	6.1	.....	7.2
22	.....	6.9	6.5	.....	6.1	6.2	6.6	7.5
23	.....	6.4	6.5	6.2	6.1	6.2	6.6	8.1
24	.....	6.3	6.6	6.2	6.1	.....	6.6	8.4
25	.....	6.3	.....	6.3	6.0	6.0	.....	.....
26	8.2	6.7	6.5	6.3	.....	6.0	6.7	.....
27	8.2	.....	6.5	6.3	6.0	5.9	6.7	8.4
28	8.0	6.6	6.5	6.4	6.0	5.7	.....	8.4
29	7.9	6.5	6.9	.....	6.0	5.8	6.7	8.4
30	.....	6.5	7.3	6.6	6.0	6.1	6.5	8.0
31	.....	.....	7.2	6.1	.....	6.1	.....	8.0

Daily gage height, in feet, of Grand River at Grand Rapids, Michigan, for 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	9.8	12.2	14.1	.....	6.8	6.9	6.4	6.6	6.8	7.4	7.8
2	.....	9.7	11.9	13.9	8.1	6.4	7.0	6.4	6.7	.....	7.4	7.7
3	7.9	9.4	11.4	.....	8.1	6.9	.....	6.4	6.6	6.9	7.3	7.7
4	7.9	9.2	10.6	12.4	8.1	6.1	.....	6.5	.....	6.7	7.1	.....
5	7.4	9.3	10.2	11.6	8.0	.....	6.6	6.6	.....	6.4	7.2	7.5
6	7.4	9.1	.....	11.2	7.9	6.2	6.6	6.5	6.6	6.3	.....	7.5
7	7.4	9.9	9.4	10.7	7.8	6.4	6.7	.....	6.6	6.3	7.4	7.4
8	7.4	9.4	9.2	10.3	.....	6.5	6.5	6.8	6.6	6.5	6.9	7.2
9	.....	9.1	9.6	10.0	7.6	6.6	6.5	6.8	6.6	.....	7.3	7.4
10	6.8	8.9	11.9	.....	7.6	6.6	.....	6.9	6.5	6.7	7.3	7.4
11	6.9	9.8	13.5	9.5	7.4	6.8	6.4	6.8	.....	6.6	7.4	.....
12	6.7	11.7	15.7	.....	7.3	.....	6.5	6.7	6.2	6.4	7.5	7.9
13	6.9	.....	.....	9.0	7.2	6.7	6.3	6.8	6.2	5.5	.....	8.3
14	7.4	12.5	18.7	8.8	7.1	7.0	6.4	.....	6.4	6.2	7.7	8.2
15	7.6	12.8	19.5	8.4	.....	6.6	6.3	6.7	6.2	6.4	7.9	8.2
16	8.0	13.0	19.7	8.4	6.9	7.2	6.3	6.8	6.8	.....	8.0	8.1
17	8.0	13.1	19.2	.....	6.9	7.4	.....	7.2	6.8	6.7	8.2	7.8
18	7.8	12.9	18.6	8.2	6.8	7.0	6.4	8.1	.....	6.9	8.2	.....
19	7.8	12.9	18.1	8.2	7.2	.....	6.4	7.5	6.9	6.9	8.4	.....
20	7.7	.....	.....	8.4	8.0	6.9	6.5	7.5	6.8	6.8	.....	8.1
21	7.9	12.9	17.0	8.4	7.9	6.9	6.4	.....	6.5	7.3	8.7	7.4
22	8.9	.....	16.7	8.5	.....	6.5	6.4	9.1	6.5	7.6	8.8	7.7
23	8.4	13.1	16.6	8.7	.....	6.4	6.4	7.0	6.8	.....	8.8	8.0
24	9.0	13.1	16.4	.....	7.8	6.8	.....	7.0	7.2	7.6	.....	8.3
25	9.2	13.1	15.8	8.8	7.7	7.0	6.4	6.8	.....	7.3	8.2	.....
26	10.2	13.1	15.2	8.7	7.5	.....	6.4	6.8	7.6	7.5	8.2	.....
27	9.4	.....	.....	8.8	7.3	7.4	6.2	6.8	7.6	7.6	.....	9.2
28	9.6	12.4	14.2	8.6	7.3	7.3	.....	.....	7.2	7.6	7.8	9.9
29	9.6	.....	13.9	8.5	.....	7.0	6.2	6.8	6.8	7.7	7.9	9.6
30	9.4	.....	14.0	8.3	.....	7.0	6.2	6.6	6.8	.....	7.9	9.2
31	.....	.....	14.2	.....	7.0	.....	.....	6.6	.....	7.6	.....	10.0

Daily gage height, in feet, of Grand River at Grand Rapids, Michigan, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	9.9	14.1	10.0	9.3	8.6	6.0	6.9	6.4	.....	6.6	6.7
2	.....	9.8	14.3	.....	9.4	8.4	.....	6.8	6.4	7.2	7.0	6.7
3	10.0	9.4	14.7	9.9	9.5	8.3	6.2	6.5	.....	6.7	7.0	.....
4	9.3	9.4	15.3	10.4	9.4	.....	.....	.....	.....	6.7	7.0	6.5
5	10.2	.....	.....	11.4	9.7	7.9	7.0	6.8	6.4	6.7	6.8	.....
6	10.3	9.0	14.9	13.1	9.6	7.6	6.7	.....	6.5	6.7	7.1	6.3
7	13.0	8.9	14.6	14.0	.....	7.6	6.8	6.9	6.6	6.8	7.0	6.3
8	.....	.....	14.2	14.6	8.7	7.4	.....	6.6	6.7	.....	6.9	.....
9	12.6	.....	13.0	.....	8.5	.....	.....	6.6	6.7	6.6	6.8	.....
10	12.0	.....	11.9	16.0	8.3	.....	.....	6.5	.....	6.4	6.8	.....
11	12.8	.....	11.4	16.3	8.2	.....	.....	6.6	6.7	6.7	7.0	6.8
12	11.2	.....	.....	16.5	8.2	7.4	.....	6.4	6.6	6.6	.....	7.6
13	11.2	8.1	12.5	16.5	7.6	.....	.....	.....	6.7	6.5	6.9	7.5
14	11.4	8.1	12.8	16.4	.....	.....	6.6	6.5	6.5	6.6	7.0	7.5
15	.....	8.1	13.1	16.2	7.9	7.4	6.9	6.4	6.6	.....	7.0	7.6
16	12.3	8.4	13.3	15.7	7.6	.....	.....	6.5	6.5	6.9	7.2	.....
17	12.4	8.4	13.9	14.9	7.7	6.8	6.9	6.5	.....	6.8	6.8	.....
18	12.4	8.1	13.3	14.2	7.7	.....	6.9	6.4	6.7	6.9	7.2	7.4
19	12.3	.....	.....	13.4	7.7	.....	.....	6.4	6.9	7.0	.....	7.2
20	12.0	9.1	12.2	12.3	7.7	6.5	6.9	.....	6.9	6.8	7.0	7.3
21	11.8	9.4	12.3	11.8	.....	.....	6.6	6.4	6.7	6.8	7.0	7.2
22	.....	.....	12.3	11.1	7.6	.....	6.6	.....	6.9	.....	6.9	7.0
23	10.6	9.4	12.1	.....	7.4	.....	.....	.....	.....	6.9	6.6	.....
24	10.3	9.4	11.3	10.4	7.2	.....	6.8	6.6	.....	6.6	6.6	.....
25	9.9	9.3	11.0	10.0	7.2	6.1	6.7	6.6	7.4	6.5	6.8	.....
26	.....	.....	.....	9.9	7.1	6.2	7.0	6.6	7.6	.....	.....	7.5
27	10.6	13.7	10.5	9.7	7.0	.....	7.1	.....	7.3	.....	6.6	7.4
28	10.0	14.0	10.8	.....	.....	.....	7.0	6.4	7.3	6.8	.....	7.6
29	.....	.....	10.8	9.4	8.1	6.2	6.9	6.3	7.1	.....	6.4	7.6
30	9.8	.....	10.2	.....	.....	.....	.....	6.3	.....	7.2	.....	7.6
31	9.9	.....	.....	.....	8.6	.....	7.1	6.4	.....	7.0	.....	.....

Daily gage height, in feet, of Grand River at Grand Rapids, Michigan, for 1900

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	.....	.....	8.3	16.8	17	.....	12.3	8.9	9.8
2	.....	.....	8.3	16.7	18	.....	11.5	8.7	.....
3	.....	.....	8.1	16.5	19	.....	11.0	8.7	.....
4	.....	.....	7.9	16.3	20	.....	10.6	8.7	.....
5	.....	.....	7.9	16.1	21	.....	10.2	8.7	.....
6	.....	.....	7.9	15.7	22	7.9	.....	8.8	.....
7	.....	.....	7.9	15.1	23	7.9	9.7	9.8	.....
8	.....	11.6	7.9	.....	24	7.7	9.3	11.4	.....
9	.....	14.1	8.1	13.5	25	7.4	9.0	12.2	.....
10	.....	14.6	8.1	12.7	26	7.0	8.7	12.8	.....
11	.....	13.9	7.9	11.8	27	6.7	8.5	13.5	.....
12	.....	13.4	8.0	11.2	28	7.0	8.3	15.4	.....
13	.....	12.8	8.1	10.6	29	8.7	.....	16.7	.....
14	.....	12.7	8.2	10.3	30	8.7	.....	17.0	.....
15	.....	12 8	8.2	.....	31	8.5	.....	17.0	.....
16	.....	12.8	8.2	10.0					

In 1899 the following measurements of the volume of flow of the stream were made under Mr. Bunker's direction. The measurements were made by means of rod floats spaced at intervals of 20 feet across the channel, and timed through a distance of 100 feet.

Discharge measurements of Grand River.

Date.	Location of section.	Elevation of water surface, Lake Michigan datum.	Corresponding stage at Grand Rapids gage.	Mean area of section.	Mean velocity per second.	Discharge.
1899.		*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-feet.*
Apr. 13	Brick House	14.514	16.49	6,131.6	3.061	18,770
Apr. 23	do	8.968	11.09	3,337.6	2.237	7,465
June 19	do	4.048	*a* 6.39	1,437.6	1.377	1,980
June 29	do	3.480	6.17	1,177.0	1.187	1,397
Aug. 31	do	3.301	6.44	751.2	1.210	909
June 16	Lamont	1.077	*a* 7.09	1,699.1	1.206	2,048
June 29	do	.487	6.17	1,402.2	.957	1,342
Sept. 8	do		6.69	1,214.2	.749	910
Apr. 19	Grand Rapids	13.334	13.39	4,091.4	2.584	10,571
June 28	do	6.142	6.14	784.3	1.908	1,492
June 30	do	6.168	6.17	619.5	1.756	1,098

a Approximate; interpolated.

The relation between the various sections is shown in the following table:

Table showing relation between sections on Grand River where discharge measurements were made.

Location.	Distance below Grand Rapids.	Drainage area.	Proportional drainage area at Grand Rapids.
	Miles.	*Sq. miles.*	*Per cent.*
Brick House	4.0	4,961	98.7
Lamont	16.5	5,179	94.6
C. & W. M. R. R. bridge, Grand Rapids	0.0	4,900	100.0

A gaging was made at Grand Rapids on July 13, 1898, by W. M. Mills, C. E., from which the flow was estimated at 1,000 second-feet. The results of all gagings thus far made are summarized in the following table, the results of measurements made below Grand Rapids having been reduced to equivalent flow at the Chicago and West Michigan Railroad bridge:

Table showing discharge of Grand River at Chicago and West Michigan Railroad bridge at Grand Rapids.

Date.	Hydrographer.	Stage at Grand Rapids gage.	Discharge.
		Feet.	*Sec.-feet.*
September 8, 1899	Geo. W. Bunker	6.69	862
August 31, 1899	do	6.44	897
1891	Fred Morley	5.67	981
July 13, 1898	W. M. Mills	6.29	1,000
June 30, 1899	Geo. W. Bunker	6.17	1,098
June 29, 1899	do	6.17	1,270
Do	do	6.17	1,379
June 28, 1899	do	6.19	1,492
June 16, 1899	do	7.09	1,937
June 19, 1899	do	6.39	1,954
1891	Fred Morley	7.32	2,151
1891	do	10.32	5,514
April 22, 1899	Geo. W. Bunker	11.09	7,368
April 19, 1899	do	13.39	10,570
1891	Fred Morley	14.32	12,382
April 13, 1899	do	16.49	18,527

Two gagings of the low-water flow of Thornapple River were made by L. W. Anderson on September 14, 1899, near the mouth of the stream and just above the village of Ada. The velocities were determined by means of both surface and rod floats, which were timed while passing through 100-foot sections. The flow was found to be 155 second-feet, or 0.19 second-foot per square mile from a drainage area of 824 square miles.

Float measurements of Flat River about 7½ miles above its mouth have been made by R. J. M. Danley. Soundings were taken every 10 feet across the channel, and rod floats were put in at the same intervals. The velocity was determined by timing the floats while passing a distance of 200 feet. The drainage area above the point of measurement is 556 square miles, 46 square miles less than at the mouth of the stream.

Discharge measurements of Flat River about 7.5 miles above its mouth.

Date.	Discharge.	
1898.	*Second-feet.*	*Sec.-ft. per sq. mile.*
July 16	215	0.39
July 29	215	0.39
September 5	220	0.40

Mr. Danley states that these measurements represent extreme low water preceded by a period of six weeks with little or no rain.

Arrangements have been made with L. W. Anderson, C. E., for the continuation of gagings of Grand River at Grand Rapids. A gage has been placed at the Fulton street bridge where observations of the stage of the water are taken twice daily. Current-meter measurements of the flow will be made, from which, with the measurements already available, a rating curve for the Grand Rapids cross section can be prepared.

A station has also been established on Grand River at the Schuyler street bridge in North Lansing. The river freezes over through nearly its entire length above Lansing, and in the spring large quantities of ice are brought down. At the point selected for gaging, however, the river does not freeze over, owing to the presence of a dam an eighth of a mile above.

Two miles above the North Lansing gaging station Grand River receives the drainage from Red Cedar River, on which a gaging station was established in January, 1901. The gage is located at the Grand Trunk Railroad bridge on the grounds of the Michigan Agricultural College. The stream is narrow, with gravel bed and without flood plains; the current is moderate.

The station on Red Cedar River, as well as that at North Lansing on Grand River, is under the immediate direction of Prof. H. K. Vedder, of the Michigan Agricultural College.

The drainage areas above the stations are as follows:

Drainage areas above gaging stations.

River.	Location.	Area.
		Sq. miles.
Grand River	Fulton street bridge, Grand Rapids	4,900
Do	North Lansing	1,238
Red Cedar River	Michigan Agricultural College	358

The fall and the power in use at the principal dams on the main river and its branches are given in the following table. There is no storage developed on the stream. The dams are of timber, usually provided with logways, though the logging industry on the river is now practically at an end. During the winter months anchor ice is a frequent source of annoyance to water-power users. The present development involves two power canals which run parallel with the river.

Developed water powers on Grand River and its tributaries.

Stream.	Location.	Number of dam.	Number of mills at dam.	Effective head or fall.			Rated power of water wheels reported.
				Greatest.	Least.	Average.	
				Feet.	*Feet.*	*Feet.*	*Horsepower.*
Grand River	Grand Rapids	1	24	15	6.5	12.5	2,000
Do	Lyons	2	3	9	4.0	7.5	150
Do	Three miles above Lyons.	3	1				
Do	Portland	4	1				241
Do	do	5	2				
Do	Grand Ledge	6	2	9	6.0	7.5	130
Do	do	7	None.				
Do	North Lansing	8	6	9	8.0	7.0	200
Do	Eaton Rapids	9	2	9	5.0	7.5	140
Do	Winfield	10	2				
Do	Jackson	11					
Buck Creek	Grandville	1	1			13.0	400
Rogue River	Childsdale	1	1	18	8.0		418
Do	Rockford	2	1				
Porter Creek	Edgerton	1	1	14	12.0	13.0	52
Thornapple River	Ada	1	2	8	4.0	10.0	32
Do	Alaska	2	2			6.0	90
Do	Labarge	3	1				
Do	Middleville	4	3				
Flat River	Lowell	1	1			8.0	297
Do	Three miles above Lowell.	2	1	12		11.0	466
Do	Alton	3	2				
Do	Belding	4	1				186
Do	Greenville	5	1				
Lookinglass River	Portland	1	2	8	4.0	7.0	203
Red Cedar River	Okemos	1	2				
Do	Williamstown	2	2				

Water power was originally developed at Grand Rapids in 1836 by the construction of a rubble diverting or wing dam on the limestone ledge at the east side of the stream. In 1851–52 a dam was built across the stream and the width of the east side canal was increased to 60 feet, with the intention of providing slack-water navigation past the Long Rapids at this point. In 1866 W. T. Powers purchased the

water privilege on the west side of the stream, and joined with the power users on the east side to build the present timber dam, the crest line of which is 678 feet long. The east side canal is 2,560 feet long and the west side canal 3,750 feet long.

Where the space between the canals and river does not permit of the erection of mills or factories, wheel pits are placed at the river's edge and the power is carried to the mills by telodynamic transmission.

Each canal is entitled to half the flow of the stream. Water privileges on the east side were sold by priority, beginning at the lower end of the canal. The flow in the west side canal, constituting half of the power of the stream, was divided into 66 equal parts or "runs." The net power of one run of stone, at the ordinary stage of the stream and under a head of 12½ feet, has been fixed at 15 horsepower. On this basis the ordinary effective power available at Grand Rapids is estimated at 2,000 horsepower. The power is utilized in the manufacture of furniture, in flour mills, machine, iron, and brass works, and for the generation of electricity. In addition power is transmitted electrically to Grand Rapids from the plant of the Peninsular Electric Company on Flat River, above Lowell. The transmission line is 16 miles long, the tension 10,000 volts.

The foregoing list of water powers does not include a number of rural grist and feed mills on the smaller tributaries, some of them very small, only permitting the mills to run intermittently by holding back the flow as pond storage. Abandoned sites where dams have been washed out are not infrequently found. These were used to supply power for sawmills which have long since ceased to be operative through lack of timber supply.

The fall at Grand Rapids aggregates 18 feet, and the available power could be greatly increased by constructing a new dam, increasing the head, and concentrating the entire flow in one wheel pit, for the generation of electricity. It is estimated that an average of 2,200 horsepower net can be obtained 8 months of the year, from May to December, while during the four spring months a minimum of 3,200 horsepower will be available, with the exception of a few days, when the head will be reduced by backwater to 6 feet or less. The plan contemplates the erection of a 12-foot concrete dam, the construction of a power canal along the stream bed, and the excavation of the tailrace channel 2½ feet below the present bed of the river. It would admit of the filling in of the present power canals and the reclamation of valuable land along the river front.[1]

The available power of the main stream is for the most part utilized. It is stated that a site exists between Lyons and Portland where a head of 12 feet could be obtained by the erection of a dam 10 feet

[1] Report on Development of Water Power, Grand Rapids, Michigan. Rae and Monroe, Chicago, 1899.

high. A dam is also contemplated at Delta, 7 miles downstream from Lansing, where a fall of 7 feet is available.

Four miles above Lowell, Flat River forms a bend 5 miles in circumference. The natural difference in elevation of the stream at the two ends of the loop is 11 feet. By building a dam 20 feet high on the upstream side, and carrying the water across the neck of the bow, a head of 30 feet could be obtained, which would yield a minimum of 1,000 horsepower.

On Rogue River, 1 mile below Childsdale, a dam could be erected which would afford a head of 20 feet. Other unimproved privileges are at Fallassburg on Flat River, where a 12-foot head is available at Ada and Cascade on Thornapple River, and at Maple Rapids and other points on Maple River. There are also two abandoned powers on Buck Creek in the vicinity of Grandville, at each of which a head of 12 to 14 feet could be obtained.

Much of the available power on tributaries of Grand River is, however, of little value, owing to irregular flow, limited supply, and remoteness from population centers.

MUSKEGON RIVER, MICHIGAN.

The drainage basin of this stream lies immediately north of that of Grand River. Originally it was covered with pine timber, but now it is almost entirely cleared. Much of the soil is sand and gravel, unfit for profitable cultivation. Large stump-covered areas form a conspicuous feature of the topography. The drainage areas tributary to the stream are given in the following table:

Drainage areas of Muskegon River and tributary.

Stream.	Location.	Area.
		Sq. miles.
Muskegon River	Above Clam River	787
Clam River	Above mouth	307
Muskegon River	Below Clam River	1,094
Do	Above Big Rapids	1,764
Do	Above Newaygo	2,352
Do	Above mouth	2,663

In March, 1901, a station was established at the dam of the Newaygo Portland Cement Company. This dam crosses Muskegon River in a deep valley above the village of Newaygo. It is of timber, having framed cribs filled with stone. Its height is 21 feet; it rests on a hardpan foundation, and is considered to be practically water tight. It is provided with a main spillway, with logways, and with four floodways. The floodways are provided with Taintor segmental flood gates, which are operated by a traveling crab. A record is kept of the time and amount of opening of the flood gates and logways, as well as of the depth of water on the crests of the spillways. Ordinarily the flood gates and logways are closed, and the entire flow

passes over the main spillway or through the turbines. Water is carried from the pond to the power house by a short headrace separated from the stream channel by a crib breakwater.

The power house contains two pairs of 35-inch Leffel standard turbines on horizontal shafts. The water wheels are connected to electrical generators by endless rope drives. The power will be used for driving machinery in the adjoining cement mills, and the load and consequent discharge of the turbines will be fairly constant. The record kept for the water wheels includes working head, hours run per day, and average width of gate opening for each pair of wheels, as indicated by the Lombard governors.

A gaging of Muskegon River at Big Rapids was made August 27, 1881, by Frederick P. Stearns, civil engineer, and the discharge was found to be 877 second-feet. This amount is taken as the ordinary flow, and is used in partitioning the water power among the several privileges at Big Rapids.

The Newaygo dam is the first one above the mouth of the stream. An effective head of 14 feet is obtained there. Power is also developed at Big Rapids, where there are two dams. The lower dam is a rough timber structure, built with a view to its use in log driving. One hundred and seventy-two horsepower is now in use for the generation of electricity, the head obtained being 8 feet. At the upper dam in Big Rapids power is distributed through two lateral hydraulic canals. The total flow is estimated as equivalent to the discharge through an orifice of 6,758 square inches area under a head of 8 feet, with a coefficient of contraction of 0.7. Each user is entitled to install wheels having a certain number of square inches vent. The head varies from 6½ to 11 feet, the average or ordinary head being 8 or 9 feet. The rated power of the turbines installed is 668 horsepower. It is stated that but 350 horsepower is actually in use. The power utilized at Newaygo and Big Rapids aggregates 1,000 horsepower. Aside from the foregoing, there is no power developed within the drainage basin, except in a small way on certain tributaries.

From the vicinity of Evart to Newaygo, Muskegon River flows between high banks, and has a rapid fall. Levels, which have been run for this purpose, show that within a distance of 10 miles, 5 miles each way from Big Rapids, there is a total fall of 104 feet. Of this 16 feet is now utilized, leaving an available fall of 88 feet. There are favorable sites for the location of dams, so that practically the entire fall could be economically developed. At Rogers's bridge, 6 miles below Big Rapids, surveys have been made for the erection of a dam to give a head of 35 feet.

In connection with power development, good opportunities exist for the conservation of flow by artificial storage. The water-surface areas of the principal lakes of the watershed and of the tributary drainage which they control is given below.

Drainage and surface areas of lakes in Muskegon River watershed.

Lake.	Drainage area.	Water surface.
	Sq. miles.	*Sq. miles.*
Muskrat Lake and group	57	8.0
Clam Lakes	67	6.7
Higgins Lake	67	15.0
Houghton Lake (not including Higgins Lake)	185	31.0
Higgins and Houghton lakes	252	46.0

In the upper portion of the watershed there is a total lake area of about 110 square miles. Formerly a lumbermen's dam was maintained for the purpose of flooding logs between Houghton and Higgins lakes, but this has been washed out. A properly constructed dam at this site would flow an area of 15 square miles and would yield a storage of 400,000,000 cubic feet per foot of depth. A lumbermen's dam, built of logs and earth, which still remains about a mile below the foot of Houghton Lake, raises the water level in that lake 4 feet, providing a storage of, in round numbers, 3,350,000,000 cubic feet. Thomas H. Coughlin, superintendent of the Muskegon Booming Company, states that a dam could be constructed at this site which would admit of a total storage 8 feet in depth and would greatly increase the flooded area over that of the present lake.

HURON RIVER, MICHIGAN.

This river receives drainage from a broad, flat basin interspersed with lakes, situated in southeastern Michigan. The inland basin is connected with Lake Erie by a long, narrow valley, in which occurs a large portion of the fall and available power of the stream.[1] A gaging station has been established at Ann Arbor, under the immediate charge of Prof. J. B. Davis, of the University of Michigan. Current-meter measurements are made from a temporary bridge or by fording. The stream at this point is winding. It flows in a shallow channel, and ordinarily does not overflow its banks. The bed is generally of gravel. The river usually freezes over during the winter, except immediately below the dams. Natural storage in the numerous lakes and marshes regulates the flow to some extent. The character of the watershed has changed somewhat in recent years. Areas of tamarack swamp lands, the soil of which was formerly a quaking bog, have been cleared and drained and are now under cultivation. The drainage area above the mouth of the river is 1,043 square miles; above Ann Arbor it is 841 square miles. A gaging of the bank-full flow of the stream at the Geddes dam, 3 miles below Ann Arbor, was made by Professor Davis, and the estimated discharge was 1,200 second-feet. The Geddes dam has a flat crest and is practically water tight. The

[1] A report on the water power of Huron River, by James T. Greenleaf, C. E., was published in the Tenth Census of the United States, Vol. XVI, Water Power, Pt. I, pp. 443-495.

length of the crest is 200 feet and the depth of water on the crest at the time the measurement was made was 1.7 feet.

THUNDER BAY RIVER, MICHIGAN.

Thunder Bay River is joined by two large branches 8 and 10 miles above its mouth, respectively. These branches, as well as the main stream, are further subdivided at short distances upstream, so that the river is of relatively small magnitude, except for a few miles near its mouth, where occurs the outcrop of the Traverse shales. It is in passing over this rock ledge that the most rapid fall of the stream occurs. The drainage area was formerly heavily timbered with Michigan pine. Most of the pine has, however, been cut, but a large amount of small conifers, hard woods, white birch, and cedar remains, so that the watershed may be considered as representing a forested rather than a cleared area. A record of precipitation is kept at Alpena, near the mouth of the stream. The outcrop of the Traverse and St. Clair shales crosses the watershed in a northeast-southwest direction, crossing the river channel a few miles west of Alpena. The surface above the line of this outcrop is almost continuous limestone, composed of calcium carbonate of 96 to 98 per cent purity, small areas being covered with sand or with thin drift deposits.

No water powers of importance have been developed on either of the branches. On the main stream there are two power dams. The lower one, which is at Alpena, was constructed in 1862. It is 1 mile from the head of Thunder Bay, an arm of Lake Huron. The river is navigable to the dam, forming a harbor. The dam and privileges of the river are owned jointly by the Alpena Waterworks Company and the Alpena Booming Company. The water wheels installed have a rated capacity of 864 horsepower under a head of 9 feet. The power is used for pumping the municipal water supply and for the generation of electricity. The second dam is at the mill of the Fletcher Paper Company, 4 miles above Alpena, and 2,000 horsepower is developed from a fall of 17 feet. The only dams above the Fletcher mills are those used for floating logs. Spruce dam, at Long Rapids, gives a head of 7 or 8 feet. At Lower Rapids a head of 20 feet could be obtained by the construction of a dam.

The drainage basin of Thunder Bay River contains thirty lakes, with an average area of about 1 square mile. In addition to these is Hubbard Lake, which has a water surface of 13.4 square miles. A timber dam at the foot of the latter lake produces a storage depth of 5 feet, with an aggregate storage capacity of 1,867,500,000 cubic feet, equivalent to a flow of 68 second-feet for thirty days. A similar dam at the foot of Beaver Lake gives a storage depth of 6 feet. The water from Beaver Lake is used chiefly for driving logs.

The limestone area contains numerous sink holes, often deep and precipitous. Surface water entering these pits disappears with greater

or less rapidity by finding outlets to a lower level through limestone fissures. Such a pocket, known as Sunken Lake, is located near the north branch of Thunder Bay River, and it absorbed the entire flow of that tributary, involving a considerable loss to power users, until, in 1900, a clay puddle dam was constructed across the channel leading from the stream to the sink hole in such a manner as to turn the water down its original channel. Owing to the pervious nature of the rock strata the effective and apparent boundaries of the watershed may differ materially.

The drainage areas tributary to the stream are as follows:

Drainage areas of Thunder Bay River and tributaries.

Stream.	Location.	Area.
		Sq. miles.
South Branch	Above mouth	454
North Branch	do	199
Thunder Bay River	Above mouth of North Branch	580
Do	Above mouth of South Branch	789
Do	At Alpena	1,267
Hubbard Lake	(Water surface)	134
Do	(Drainage area)	148

A gaging station has been established in connection with the dam and mill of the Fletcher Paper Company. The record kept includes the depth flowing over the main dam and logway and the discharge through the turbines. There are four pairs of Trump Model wheels set on horizontal shafts. The water wheels are not run otherwise than at full gate. The dam, which is of timber crib work filled with stone, is on a limestone rock foundation and is 20 feet high and 454 feet long between abutments. A log slide divides the spillway into two sections. The slide has a channel 6 feet in width and is closed by plank flashboards to an elevation of 1 foot above the crest line. The spillway has a vertical face and a crest 4 feet in width, sloping upstream, with a batter of 1 vertical to 5 horizontal. The upstream face of the dam has a batter of about 3 horizontal to 1 vertical. The left section of the spillway is 255¼ feet long. The flat crest is covered with sheet iron, slightly rounded at the lip. The right spillway section is 181.7 feet in length, and the crest is faced with planking.

ST. JOSEPH RIVER, MICHIGAN.

St. Joseph River rises at Bunday Hills, in northern Hillsdale County, Michigan, flows southwesterly into Indiana, turns northward at South Bend, recrosses the State line near Bertrand, and debouches into Lake Michigan at St. Joseph. The total area drained is, approximately, 4,586 square miles, of which 2,916 square miles are in Michigan and 1,670 square miles in Indiana. The drainage basin contains more than 400 small lakes, varying in surface area from an eighth of a square mile to 6 square miles. Of these, approximately 100 are in

Indiana and 300 in Michigan. No storage is developed on the stream. The drainage areas of the river and its more important tributaries are given in the following table:

Drainage areas of St. Joseph River and its tributaries.

Stream.	Location.	Area.
		Sq. miles.
St. Joseph River	Above Three Rivers	863
Prairie River	Above mouth	164
Portage River	do	178
Rack River	do	213
St. Joseph River	Below Three Rivers	1,417
Do	Above Niles	3,616
Dowagiac River	Above mouth	281
St. Joseph River	Below mouth of Dowagiac River	3,898
Do	Above mouth of Pawpaw River	4,157
Pawpaw River	Above mouth	429
St. Joseph River	Below mouth of Pawpaw River	4,586

The drainage basin lies in a completely glaciated region, and is overlain with diversified drift deposits. The current of the river from South Bend to its mouth was formerly reversed, and this valley formed an outlet for the waters of Lake Michigan, which turned to the southwest, through Kankakee River, at South Bend, and thus reached the Mississippi through Illinois River. Leverett states[1] that there is still a well-defined river channel connecting St. Joseph River with the Kankakee, the surface of which, where it leaves the St. Joseph, is but 45 or 50 feet above the present low-water surface of that stream. The watershed of St. Joseph River in Michigan contains relatively little marsh land not artificially drained and relatively little uncleared land. About a third of the lakes are, however, without outlets. The proportion of undrained lakes in Indiana is smaller, and the swamp lands are much more extensive.

Elkhart River, one of the principal Indiana tributaries of the St. Joseph, drains an area of about 500 square miles which contains large lakes and extended swamp areas, with the principal fall occurring in the passage of the stream from marsh to marsh.

St. Joseph River was formerly navigable for boats as far as Elkhart, or perhaps above, and the older dams were provided with locks, long since abandoned and closed. Prof. James Du Shane is of the opinion that at the present time the low-water depth of the river over the rapids is from 1½ to 2 feet. A rise of 5 feet represents ordinary high water, and a rise of 8 feet represents extreme high water. Within the last twenty-two years two freshets have occurred which raised the water in some portions of the river higher than here given. The average width from bank to bank is 400 feet, and the average slope from Elkhart to Berrien Springs is 2.1 feet to the mile.

The first water-power mill in southwestern Michigan was constructed by Eli Ford, in 1827, on Dowagiac Creek, near its confluence with St.

[1] Water resources of Indiana and Ohio, by Frank Leverett: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. IV, p. 439.

Joseph River, at Niles. This mill, known as the Volante mill, has been in operation since 1828. Power development on St. Joseph River began at a somewhat later date. The dam at Niles was built about 1856. At South Bend the power was developed by the South Bend Manufacturing Company, and was sold in the form of rights to the flow through wheels of a certain number of square inches vent under the available head. The dam is 10 feet high, with lateral power canals on each side. Under an order of the court the water is to be maintained at a stage not lower than 6 inches below the crest of the dam. Nineteen privileges have been granted, calling for a flow of 3,195.5 cubic feet per second under a head of 9.5 feet. Fourteen of these privileges are now in use. The minimum flow of the stream is usually considered to be 1,000 second-feet, but it is stated to have gone considerably lower during the months of July and August, 1895. At Elkhart there is a similar power development, the flow of the stream being divided among eleven mills. The power at Elkhart was originally divided by priority, the amount being specified as so many runs of stone, or "sufficient for the purpose of the mill."

The following table gives the principal facts regarding water power in the St. Joseph River Basin, so far as reported:

Developed water powers in St. Joseph River Basin.

Stream.	Location.	Dam number.	Number of mills at dam.	Effective head or fall.			Rated power of water wheels reported.
				Greatest.	Least.	Average.	
				Feet.	*Feet.*	*Feet.*	*Horse-power.*
St. Joseph River	Buchanan	1				11.0	
Do	Niles	2	2			12.0	4,018
Do	South Bend	3	14	12.0	4.0	9.5	2,588
Do	Mishawaka	4	3	11.0	7.0	10.0	1,760
Do	Elkhart	5	3	13.0	6.0	10.0	1,920
Do	Constantine	6					
Do	Three Rivers	7	3	10.0	6.0	8.5	600
Do	Below Mendon	8					
Do	Burlington	9					
Do	Tekonsha	10	1	8.0	6.0	7.0	89
Pawpaw River	Watervliet	1	1	14.0	6.0	10.0	600
Do	Hartford	2					
Do	Lawrence	3					
South Branch of Pawpaw River.	Pawpaw	1	1	14.0	12.5	13.5	132
Do	do	2	1	17.0		17.0	108
Spring Brook	Almena	1					
Dowagiac Creek	Niles	1	2			12.0	356
Do	Above Niles	2	1			14.5	715
Pokagon Creek	Summerville	1					
South Branch of Dowagiac Creek.	Dowagiac	1	1	10.0	8.0	9.0	95
Do	Lagrange	2					
Christiana Creek	Elkhart	1					
Elkhart River	do	1		8.5	4.0	7.0	60
Do	Goshen	2	2	17.0	10.0	14.5	700
Do	Benton	3					
Portage River	Three Rivers	1	1	10.5	8.5	9.5	297
Rocky River	do	1	1	15.0	11.0	14.0	459
Swan Creek	Colon	1	1	10.0	5.0	8.0	107
Coldwater River	Union City	1	1	9.0		9.0	52
Do	Above Union City.	2	1				
Do	Hodunk	3	1				
Nottawa Creek	Athens	3	1	9.0	6.5	8.0	35

There are a number of undeveloped powers between the present dams, and projects are now formed to utilize them. The power is to be used largely for the generation of electricity for transmission to neighboring towns. A part of it will supplement the power at existing dams. At Berrien Springs, Michigan, a concrete dam 30 feet in height is proposed. This will make available a fall of 20 feet. Eighteen water wheels of a rated capacity of 7,500 horsepower are to be installed. This power is in sec. 18, T. 17 W., R. 6 S., Michigan meridian. At Bertrand, Michigan, a fall of 12 feet could be obtained by the construction of a suitable dam.

Two available sites for dams exist between Mishawaka and Elkhart, Indiana. The former is in sec. 11, T. 38 N., R. 2 E., second principal meridian, where a 12-foot fall is available. The width of the river is about 350 feet. The latter site, called the Twin Branch site, is in sec. 12, T. 37 N., R. 3 E., second principal meridian. A dam 422 feet long is proposed at this point, which would make available a fall of 21 feet.

At Bristol, Indiana, a dam formerly existed, but it was washed out. A site exists in sec. 31, T. 38 N., R. 5 E., second principal meridian, where a fall of 16 feet could be obtained by the construction of a dam 600 feet in length.

At Mottville, Michigan, in sec. 6, T 8 S., R. 5 W., Michigan meridian, a fall of 9½ feet could be obtained by the construction of a dam 540 feet in length.

An undeveloped water power also exists near Three Rivers, Michigan, in sec. 1, T. 6 S., R. 11 W., where about 9 feet fall could be obtained.

The available power of tributaries of St. Joseph River is of little value, as is indicated by the existence of numerous abandoned sites where dams have been carried away by freshets. At Ligonier, Indiana, a dam formerly existed on Elkhart River, but it was washed out. There are three undeveloped powers on Pawpaw River, in Antwerp Township, Van Buren County, Michigan, with falls of 9 feet, 14 feet, and 9 feet, respectively.

Arrangements have been made with the Berrien Springs Power Company for the maintenance of a record of flow of St. Joseph River at their plant when completed. The record will include discharge over the 500-foot concrete dam, and the run of water wheels, which will be 18 in number, arranged in sets of three pairs each. In the meantime a temporary gaging station has been established at the dam of the Berrien Springs Power Company at Buchanan, Michigan, 10 miles above Berrien Springs. The dam is of timber, of the Beardsley gravity type, with a straight crest approximately 400 feet long. It is 9.83 feet high, and is built on an earth foundation.

In January, 1891, the following gaging of St. Joseph River was made by John F. Meighan at Leepers Bridge, 1 mile below the dam at South Bend:

Discharge measurement of St. Joseph River at Leepers Bridge in January, 1891.

Elevation of water surface above city datum	(feet)	7.57
Area of cross section	(square feet)	1,232
Wetted perimeter	(lineal feet)	262.91
Hydraulic mean radius		4.686
Slope	(feet per foot)	0.000378
Coefficient of roughness in Kutter's formula		0.030
Coefficient *c* in Kutter's formula		65
Mean velocity	(feet per second)	2.735
Discharge	(second-feet)	3,369

The stated depth of extreme high water on the crest of the Niles dam is 5 feet, indicating a freshet discharge of about 15,000 second-feet, or 4.5 second-feet per square mile. The extreme high-water flow over the Dowagiac River dam at Niles is stated to be 2 feet depth on the crest of the 120-foot spillway, corresponding to a flow of about 1,200 second-feet, or 4.3 second-feet per square mile, from a drainage area of 281 square miles.

KALAMAZOO RIVER, MICHIGAN.

The details of the hydrography of this stream have been given in an earlier report.[1] The drainage areas of the river and its tributaries are as follows:

Drainage areas of Kalamazoo River and its tributaries.

Stream.	Location.	Area.
		Sq. miles.
North Branch of Kalamazoo River	Albion	138
South Branch of Kalamazoo River	do	136
Kalamazoo River	Below junction of North and South branches	274
Do	Marshall	443
Do	Above Battle Creek	608
Battle Creek	At mouth	244
Kalamazoo River	Below Battle Creek	847
Do	At Plainwell	1,307
Do	At Allegan	1,508
Do	At mouth	2,064

The accompanying table gives a summary of the developed water powers of the drainage basin. Most of the powers on the main stream are utilized. In 1898–99 a dam giving 23 feet head was built between Allegan and Otsego, to develop 2,000 horsepower for electrical transmission. This plant has the merit of being the first large long-distance transmission plant in the State.[2] A portion of the fall between this dam and Allegan is still undeveloped, and it is claimed that a head of 20 feet could be obtained by the construction of a dam 2 miles above that city. Above Otsego, on the main river, there are one or two rapids having falls of several feet which are not yet developed.

[1] Report on the run-off and water power of Kalamazoo River, by Robert E. Horton: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 30, pp. 22–38.

[2] Proc. Mich. Eng. Soc. 1900, pp. 84–91; also Engineering Record, Jan. 13, 1900.

Developed water powers in Kalamazoo River Basin.

Stream.	Location.	Number of dam.	Number of mills at dam.	Effective head or fall.			Rated power of water wheels reported.
				Greatest.	Least.	Average.	
				Feet.	*Feet.*	*Feet.*	*Horse-power.*
Kalamazoo River	Allegan	1	12				1,150
Do	Above Allegan	2	1			23.0	2,000
Do	Otsego	3	5			12.0	1,725
Do	Plainwell	4	5			9.0	786
Do	Battle Creek	5	7	12	10	12.0	469
Do	do	6	1				
Do	Ceresco	7	1			8.0	289
Do	Marshall	8	1			6.0	(a)
Do	do	9	1	14	12	13.0	200
Do	Marengo	10	1				118
North Branch	Albion	11	1				
Do	Newburg Mills	12	1				
Do	Bath Mills	13	1				33
Do	Concord	14	1			9.0	118
Do	Horton	15	1			10.0	55
South Branch	Albion	1	2				
Do	North Homer	2	1				69
Do	Homer	3	1				214
Do	Mosherville	4	1				80
Rice Creek	Marshall	1	1			12.0	136
Battle Creek	Battle Creek	1	1			6.0	86
Do	Bellevue	2	1				
Do	Olivet	3	1				
Augusta Creek	Augusta	1	1	18	17	18.0	260
Gull Lake outlet	Galesburg	1	1	13	12	13.0	81
Do	Howlandsburg	2	1	12	10	11.0	70
Do	Yorkville	3	1			20.0	80
Comstock Creek	Comstock	1	1	12		11.5	22
Portage Creek	Kalamazoo						
Wilder Creek	Eckford						
Wabasacon Creek	Bedford						
Comstock Creek	Above Comstock	2	1			23.0	35

a Undershot water wheel.

It is stated that a dam could be built 1 mile above the mouth of Swan Creek, which enters Kalamazoo River 8 miles below Allegan, and a head of 40 feet be obtained.

During a portion of 1900 a daily record of the river stage was kept at Kalamazoo, the results of which are given on the following page. Earlier records will be found in Water-Supply Paper No. 30, page 36. Arrangements have been made for the maintenance of a gaging record at the electric-power dam at Trowbridge, 6 miles above Allegan. The plant includes four pairs of 45-inch Leffel-Sampson turbines on horizontal shafts. The gate opening and discharge of two pairs are controlled by Lombard governors. The excess of flow not taken by the turbines is discharged over a spillway having three Taintor flood gates, each 20 feet long. The spillways have flat crests 20 feet in width, with slopes of 1 to 1 on the upstream and downstream faces. The discharge on the downstream side is received on a floating apron 20 feet in width, which is anchored to the flood-gate cribs by chains.

Daily gage height, in feet, of Kalamazoo River at foot of Sheldon street, Kalamazoo, Michigan, for 1900.

Day.	Sept.	Day.	Sept.	Day.	Sept.	Day.	Sept.	Day.	Sept.
6	68.45	11	68.20	16		21		26	
7	68.32	12	68.15	17		22		27	
8	68.25	13	68.00	18	68.05	23		28	
9		14	67.90	19	67.90	24		29	67.90
10	68.15	15	68.02	20	67.90	25		30	

NOTE.—On August 9 the gage height was 68.50 feet.

Daily gage height, in feet, of Kalamazoo River at Gull street, Kalamazoo, Michigan, for 1901.

Day.	Mar.	Day.	Mar.	Day.	Mar.	Day.	Mar.	Day.	Mar.
16	69.86	20	71.10	23	71.67	26	71.40	29	71.27
17		21	71.72	24	71.66	27		30	
18	70.10	22	72.12	25	71.52	28	71.48	31	
19	70.75		71.97						

NOTE.—Gage height on April 1 was 70.04 feet, and on April 12, 68.02 feet.

Daily gage height, in feet, of Kalamazoo River at extension of Paterson street, Kalamazoo, Michigan, for 1900.

Day.	Sept.	Day.	Sept.	Day.	Sept.	Day.	Sept.	Day.	Sept.
1	68.71	6	68.10	11	67.90	16		21	68.20
2	68.54	7	68.23	12		17		22	67.98
3	68.47	8	68.10	13		18		23	67.94
4	68.41	9	68.10	14		19		24	68.09
5		10	67.99	15		20			

STREAMS OF NORTHERN PENINSULA OF MICHIGAN.

The streams of the northern peninsula of Michigan are contrasted with those of the southern portion of the State by their steep slopes, rocky channels, and occasional waterfalls. They possess numerous water powers, which are almost wholly undeveloped, and many of which are in close proximity to the mining centers of the iron and copper region. Arrangements are being made for the establishment of a gaging station on one of the larger streams.

On Ontonagon River at Glenns Falls a head of 100 feet could be obtained, which would yield an estimated minimum of 4,500 horsepower. This is in sec. 31, T. 50 N., R. 31 W., about three-fourths of a mile south of the Victoria mine. Ontonagon River is the largest Lake Superior tributary in Michigan. It extends entirely across the northern peninsula, and finds its headwaters in a region of numerous small lakes near the Wisconsin-Michigan line. Its fall is mostly concentrated in the short stretch between the summit of the Michigan Range at Rockland and its entrance to Lake Superior at Ontonagon.

Owing to the lack of a map on suitable scale, the drainage area can not at present be estimated.

Dead River, tributary to Lake Superior at Marquette, possesses a fall of 850 feet in a distance of 10 miles.

Much of the southern slope of the upper peninsula drains into Menominee River, a tributary of Green Bay. A report on that river was published in the Tenth Census of the United States.[1] Other streams possessing good falls and opportunities for lake storage in the region of their headwaters are the Escanaba, Manistique, Michigamme, and Tahquemenon rivers.

MISSISSIPPI RIVER AT ST. PAUL, MINNESOTA.

Records of gage heights are maintained by the United States Weather Bureau at St. Paul, and are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 36, page 194.

Daily gage height, in feet, of Mississippi River at St. Paul, Minnesota, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	3.4	3.7	3.2	0.8	1.1	5.4	5.8	4.5	2.0
2	.....	.....	.....	3.0	3.7	3.0	.7	1.2	5.3	5.8	4.5	2.0
3	.....	.....	.....	3.2	3.8	2.9	1.0	1.2	5.0	5.9	4.5	2.0
4	a4.4	.....	.....	3.7	3.8	2.7	2.0	1.2	4.8	5.9	4.5	2.2
5	.....	.....	.....	3.8	3.8	2.6	2.6	1.0	4.7	6.3	4.6	2.3
6	.....	a6.3	a3.2	4.6	3.7	2.5	2.9	1.0	4.5	6.5	4.6	2.3
7	.....	.....	.....	5.3	3.5	2.5	2.9	1.0	4.2	6.6	4.6	2.2
8	.....	.....	.....	5.6	3.4	2.4	3.0	1.1	4.0	6.3	4.5	1.9
9	.....	.....	.....	5.2	3.3	2.4	2.9	1.2	3.9	6.2	4.4	1.9
10	.....	.....	.....	5.0	3.5	2.4	2.9	1.5	4.2	6.0	4.3	1.8
11	.....	.....	.....	4.8	3.2	1.8	2.8	2.2	4.4	5.9	4.2	2.4
12	.....	.....	.....	4.5	3.0	1.8	2.8	2.8	5.3	5.8	4.1	3.6
13	a3.9	a5.1	.....	4.3	2.9	1.9	3.0	2.9	5.8	5.7	4.0	3.5
14	.....	.....	a3.7	4.2	2.8	1.9	3.0	3.5	5.7	5.7	3.8	2.8
15	.....	.....	.....	4.1	2.8	1.5	2.8	3.7	5.5	5.4	3.5	1.8
16	.....	.....	.....	4.0	2.8	1.5	2.8	4.0	5.3	5.3	2.7	2.6
17	.....	.....	.....	4.4	2.8	1.4	2.6	4.2	5.2	5.3	2.1	2.4
18	.....	.....	.....	4.6	2.9	1.3	2.5	4.3	5.1	5.3	2.0	2.7
19	.....	.....	.....	4.8	2.9	1.3	2.3	4.2	5.0	5.2	2.0	3.3
20	.....	3.5	.....	4.6	2.6	1.2	2.2	4.0	5.2	5.1	2.1	3.0
21	a3.8	.....	.....	4.4	2.5	1.2	2.2	3.8	5.5	5.0	2.1	2.7
22	.....	.....	a3.7	4.2	2.7	1.2	2.2	3.7	5.7	4.8	2.1	2.4
23	.....	.....	.....	4.0	2.8	1.2	2.2	3.7	5.9	4.8	2.0	2.3
24	.....	.....	.....	4.0	2.8	1.2	2.1	3.9	5.9	4.6	1.9	[illegible]
25	.....	.....	.....	4.0	2.8	1.0	1.8	4.1	6.0	4.5	1.6	(b)
26	.....	.....	.....	3.9	2.7	1.0	1.5	4.5	6.0	4.5	1.3	(b)
27	.....	.....	.....	3.8	2.8	1.0	1.1	4.7	6.0	4.3	1.8	(b)
28	.....	a3.2	.....	3.8	2.8	.9	1.1	5.0	6.0	4.5	2.1	(b)
29	.....	.....	.....	3.8	3.2	.9	1.3	5.4	5.9	4.6	2.0	(b)
30	a3.6	.....	.....	3.7	3.3	.8	1.0	5.5	5.8	4.5	2.0	(b)
31	.....	.....	a3.7	.....	3.3	.....	1.0	5.4	.....	4.3	.....	a2.1

a Approximate; river frozen. b River frozen.

WEST GALLATIN RIVER NEAR SALESVILLE, MONTANA.

This station, which was established in July, 1895, is located at the highway bridge crossing the stream about 5 miles south of Salesville. It is described in Water-Supply Paper No. 36, page 195. Results of measurements for 1899 will be found in the Twenty-first Annual

[1] Vol. XVII, Water Power, Pt. II, pp. 71-81.

Report, Part IV, page 184. During 1900 the following discharge measurements were made under the direction of Samuel Fortier:

Discharge measurements of West Gallatin River near Salesville, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 23	4.86	1,944	July 12	3.61	871
June 7	5.90	3,727	Do	3.60	842
Do	5.90	3,796	August 15	3.10	512
June 18	4.72	2,028	August 25	3.15	526
June 24	4.51	2,039			

Daily gage height, in feet, of West Gallatin River near Salesville, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40			3.30	4.00	6.15	4.10	3.20	3.00	3.20	3.10	2.80
2				3.40	4.10	5.80	4.10	3.20	3.00	3.20	3.10	2.80
3				3.40	4.25	6.40	3.90	3.20	3.00	3.10	3.10	2.85
4				3.40	4.50	6.60	3.70	3.23	3.20	3.20	3.10	2.90
5		3.30		3.50	4.70	6.65	3.70	3.23	3.20	3.20	3.10	3.00
6				3.60	5.15	6.90	3.70	3.10	3.20	3.20	3.10	3.00
7			3.10	3.80	4.95	6.55	3.70	3.10	3.20	3.20	3.10	3.00
8	3.30			3.60	5.05	6.25	3.70	3.10	3.15	3.10	3.10	2.90
9				3.50	5.15	6.30	3.70	3.10	3.00	3.10	3.10	2.90
10				3.50	5.55	6.15	3.60	3.10	3.00	3.10	3.10	2.90
11				3.50	6.05	6.45	3.60	3.10	3.00	3.10	3.00	2.90
12		3.00	3.10	3.50	6.05	5.50	3.60	3.10	2.90	3.10	2.90	2.90
13				3.50	5.55	5.55	3.50	3.10	3.00	3.10	3.00	2.90
14				3.50	5.30	5.55	3.50	3.10	3.00	3.10	3.00	2.90
15	3.20			3.50	5.25	5.75	3.50	3.10	3.10	3.10	3.00	2.90
16				3.60	5.15	5.50	3.40	3.10	3.00	3.10	3.00	2.85
17				3.50	5.15	5.30	3.40	3.13	3.00	3.10	3.00	2.80
18				3.60	5.20	5.15	3.40		3.10	3.10	2.90	2.80
19				3.70	5.00	5.20	3.40	3.10	3.10	3.10	2.80	2.80
20			3.10	3.85	5.10	5.25	3.40	3.10	3.10	3.10	2.70	2.80
21		3.20		4.00	5.15	5.30	3.30	3.10	3.10	2.90	2.70	2.80
22	3.20			4.15	5.40	5.20	3.40	3.10	3.00	3.00	2.80	2.80
23				4.35	5.45	5.20	3.30	3.10	3.20	3.10	2.80	2.80
24				4.05	5.65	5.20	3.30	3.13	3.10	3.10	2.80	2.85
25				3.90	5.75	4.70	3.30	3.13	3.10	3.10	2.80	2.85
26				4.00	6.25	4.70	3.30	3.20	3.10	3.10	2.80	2.80
27				4.00	6.75	4.40	3.35	3.15	3.10	3.00	2.80	2.80
28		3.10		4.10	6.90	4.20	3.30	3.15	3.20	2.90	2.80	2.80
29	3.20		3.30	4.10	6.45	4.20	3.20	3.15	3.10	2.90	2.80	2.80
30				4.00	6.45	4.10	3.28	3.10	3.13	3.00	2.80	2.80
31					6.05		3.30	3.00		3.00		2.78

MIDDLE CREEK NEAR BOZEMAN, MONTANA.

This station, which was established August 3, 1895, is located in Middle Creek Canyon, 9 miles from Bozeman. It is described in Water-Supply Paper No. 36, page 196. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 183. During 1900 the following measurements of discharge were made under the direction of Samuel Fortier:

May 22: Gage height, 0.57 foot; discharge, 211 second-feet.
June 5: Gage height, 0.90 foot; discharge, 366 second-feet.
June 18: Gage height, 0.60 foot; discharge, 248 second-feet.
June 24: Gage height, 0.60 foot; discharge, 241 second-feet.
July 7: Gage height, 0.26 foot; discharge, 104 second-feet.
August 15: Gage height, 0.02 foot; discharge, 51 second-feet.

Daily gage height, in feet, of Middle Creek near Bozeman, Montana, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	0.30	0.10	0.00	0.00	17	.....	0.20	0.02	0.00	.....
2	.....	.30	.10	.00	.00	18	0.60	.20	.02	.00	.....
3	.....	.20	.10	.00	.00	19	.50	.20	.02	.01	.....
4	.....	.20	.10	.00	.00	20	.60	.20	.02	.01	.....
5	.....	.30	.20	.00	.00	21	.80	.10	.02	.01	.....
6	.....	.20	.10	.00	.00	22	.60	.10	.01	.00	.....
7	.....	.20	.10	.00	.00	23	.90	.10	.01	.00	.....
8	.....	.30	.10	.00	.00	24	.60	.10	.01	.00	.....
9	.....	.30	.10	.00	.00	25	.60	.20	.01	.00	.....
10	.....	.30	.05	.00	.00	26	.50	.10	.01	.00	.....
11	.....	.30	.05	.00	.00	27	.50	.10	.01	.00	.....
12	.....	.20	.04	.00	.00	28	.50	.20	.01	.00	.....
13	.....	.20	.03	.00	.00	29	.40	.10	.01	.00	.....
14	.....	.20	.03	.00	.....	30	.30	.10	.00	.00	.....
15	.....	.30	.02	.00	.....	31	.....	.10	.00	.....	.....
16	.....	.20	.02	.00	.....						

NOTE.—This station was discontinued in 1899, but was reopened on June 18, 1900. It was closed for the winter on October 13.

GALLATIN RIVER AT LOGAN, MONTANA.

This station, which was established August 24, 1893, by F. H. Newell, is located on the bridge of the Northern Pacific Railroad crossing the river at Logan. It is described in Water-Supply Paper No. 36, pages 197 and 198, where will also be found the results of measurements for 1899. During 1900 the following measurements of discharge were made under the direction of Samuel Fortier:

Discharge measurements of Gallatin River at Logan, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
May 29	3.91	4,630	August 13	0.62	349
June 15	2.32	1,966	September 4	.77	445
June 23	1.51	1,066	October 15	1.00	600
June 28	1.22	744	October 16	1.00	596
July 16	.40	239			

Daily gage height, in feet, of Gallatin River at Logan, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	1.40	2.00	3.50	1.00	0.50	0.70	0.90	1.00	1.10
2	.....	.....	.....	1.40	2.00	3.50	.90	.50	.70	.90	1.00	1.10
3	1.20	.....	.....	1.40	2.05	3.70	.90	.50	.80	.90	1.00	1.10
4	.....	.....	.....	1.40	2.30	3.70	.80	.50	.80	1.00	1.00	1.10
5	.....	.....	.....	1.40	2.30	3.75	.80	.50	.80	1.05	1.00	1.10
6	.....	.....	.....	1.40	2.50	3.90	.80	.50	.80	1.10	1.00	1.10
7	.....	1.50	1.80	1.40	2.80	3.85	.80	.50	.80	1.10	1.00	1.10
8	.....	.....	.....	1.40	2.70	3.60	.80	.60	.80	1.10	1.00	1.10
9	.....	.....	.....	1.40	2.80	3.40	.70	.60	.80	1.00	1.00	1.10
10	1.30	.....	.....	1.40	3.05	3.25	.60	.60	.80	1.00	1.00	1.00
11	.....	.....	.....	1.40	3.35	2.75	.60	.60	.80	1.00	1.00	1.00
12	.....	.....	.....	1.40	3.60	2.50	.50	.60	.80	1.00	1.00	1.00
13	.....	.....	.....	1.40	3.70	2.50	.40	.60	.80	1.00	1.00	1.00
14	.....	(a)	1.40	1.40	3.25	2.35	.40	.60	.80	1.00	1.00	1.00
15	.....	.....	.....	1.50	3.15	2.15	.40	.60	.80	1.00	1.00	1.00
16	.....	.....	.....	1.50	3.00	2.00	.40	.60	.80	1.00	1.00	1.00
17	1.30	.....	.....	1.50	3.00	2.00	.40	.60	.80	1.00	1.00	1.00
18	.....	.....	.....	1.60	3.00	1.90	.40	.60	.80	1.00	1.15	1.00
19	.....	.....	.....	1.60	3.00	1.70	.40	.60	.90	1.00	1.35	1.00
20	.....	.....	.....	1.60	3.00	1.70	.40	.60	.90	1.00	1.50	1.00
21	.....	(a)	1.50	1.60	3.00	1.55	.40	.60	.90	1.00	1.55	1.00
22	.....	.....	.....	1.60	3.00	1.50	.40	.60	.90	1.00	1.50	1.00
23	.....	.....	.....	1.80	3.00	1.50	.40	.60	.90	1.00	1.40	1.00
24	1.50	.....	.....	1.90	3.05	1.50	.40	.60	.90	1.00	1.30	1.00
25	.....	.....	.....	2.00	3.30	1.40	.40	.60	.90	1.00	1.20	1.10
26	.....	.....	.....	2.05	3.40	1.40	.40	.70	.90	1.00	1.10	1.10
27	.....	.....	.....	2.00	3.75	1.30	.50	.70	.90	1.00	1.10	1.00
28	.....	1.50	1.50	2.00	4.00	1.20	.50	.70	.90	1.00	1.10	1.00
29	.....	.....	.....	2.00	4.00	1.10	.50	.70	.90	1.00	1.10	1.00
30	.....	.....	.....	2.00	3.60	1.00	.50	.70	.90	1.00	1.10	(a)
31	1.50	.....	.....	.....	3.70	.....	.50	.70	.....	1.00	.....	(a)

a Frozen.

MADISON RIVER NEAR REDBLUFF, MONTANA.

This station, which was established May 2, 1897, is located 4 miles below the Redbluff iron county bridge over the river and 1½ miles below the mouth of Cherry Creek. It is described in Water-Supply Paper No. 37, page 205. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 186. During 1900 the following measurements of discharge were made under the direction of Samuel Fortier. Cherry Creek flows into Madison River between the gage and the point where the river is measured, and its discharge should, therefore, be added to that of the river in order to obtain the total discharge at the gage.

Discharge measurements of Madison River near Redbluff, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
June 8	2.57	4,412	June 25	.....	a 49
Do	.....	a 146	June 26	1.79	2,486
June 9	2.53	4,237	July 13	1.40	1,597
June 19	1.92	2,715	Do	.....	a 7
Do	1.92	2,848	August 16	1.30	1,434
Do	.....	a 66	Do	.....	a 9
June 25	1.85	2,610			

a Cherry Creek.

Daily gage height, in feet, of Madison River near Redbluff, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	(a)	1.00	2.00	2.70	1.60	1.40	1.40	1.50	1.50	1.40
2	.....	(a)	.....	1.00	2.25	2.50	1.60	1.40	1.40	1.50	1.50	1.40
3	.....	.....	.....	1.00	2.40	2.80	1.55	1.40	1.40	1.50	1.50	1.40
4	(a)	.....	.....	1.30	2.40	2.80	1.50	1.40	1.40	1.50	1.40	1.40
5	.....	.....	.....	1.30	2.45	2.88	1.50	1.40	1.40	1.50	1.40	1.40
6	.....	.....	.....	1.30	2.30	2.90	1.50	1.40	1.40	1.50	1.40	1.40
7	.....	.....	.....	1.40	2.35	2.90	1.50	1.40	1.40	1.50	1.40	1.40
8	.....	(a)	1.00	1.30	2.40	2.80	1.50	1.40	1.40	1.50	1.40	1.40
9	.....	.....	.....	1.30	2.45	2.80	1.50	1.45	1.40	1.50	1.40	1.40
10	.....	.....	.....	1.30	2.50	2.80	1.50	1.50	1.40	1.50	1.40	1.40
11	(a)	.....	.....	1.30	2.62	2.70	1.50	1.50	1.50	1.50	1.40	1.40
12	.....	.....	.....	1.30	2.70	2.65	1.50	1.50	1.50	1.50	1.40	1.40
13	.....	.....	.....	1.30	2.80	2.40	1.50	1.45	1.40	1.50	1.40	1.40
14	.....	.....	.....	1.30	2.70	2.30	1.50	1.40	1.40	1.50	1.40	1.40
15	.....	(a)	1.00	1.35	2.55	2.20	1.50	1.40	1.40	1.50	1.40	1.40
16	.....	.....	.....	1.40	2.45	2.10	1.50	1.40	1.40	1.50	1.40	1.40
17	.....	.....	.....	1.45	2.30	2.50	1.50	1.40	1.40	1.50	1.40	1.40
18	(a)	.....	.....	1.50	2.25	1.85	1.50	1.40	1.40	1.50	1.40	1.40
19	.....	.....	.....	1.50	2.10	1.80	1.50	1.40	1.40	1.50	1.40	1.40
20	.....	.....	.....	1.50	2.20	1.70	1.50	1.40	1.40	1.50	1.40	1.40
21	.....	.....	.....	1.50	2.23	1.70	1.50	1.40	1.40	1.50	1.40	1.40
22	.....	(a)	1.00	1.60	2.20	1.70	1.50	1.40	1.40	1.50	1.40	1.40
23	.....	.....	.....	1.70	2.25	1.65	1.50	1.40	1.40	1.50	1.40	1.40
24	.....	.....	.....	1.80	2.37	1.60	1.50	1.40	1.40	1.50	1.40	1.40
25	(a)	.....	.....	1.80	2.45	1.60	1.50	1.40	1.40	1.50	1.40	1.40
26	.....	.....	.....	1.80	2.60	1.60	1.50	1.40	1.50	1.50	1.40	1.40
27	.....	.....	.....	1.80	2.80	1.60	1.50	1.40	1.50	1.50	1.40	1.40
28	.....	.....	.....	1.80	2.90	1.60	1.50	1.40	1.50	1.50	1.40	1.40
29	.....	.....	1.00	1.80	3.00	1.60	1.50	1.40	1.50	1.50	1.40	1.40
30	.....	.....	.....	1.82	3.00	1.60	1.40	1.40	1.50	1.50	1.40	.....
31	.....	.....	.....	.....	2.95	.....	1.40	1.40	.....	1.50	.....	.....

a Frozen.

JEFFERSON RIVER AT SAPPINGTON, MONTANA.

This station, which was established by Arthur P. Davis in 1894, is located on the bridge of the Northern Pacific Railroad crossing the river at Sappington. It is described in Water-Supply Paper No. 37, pages 206 and 207, where will also be found the results of measurements for 1899. During 1900 the following measurements of discharge were made under the direction of Samuel Fortier:

Discharge measurements of Jefferson River at Sappington, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 31	5.01	5,918	July 16	1.92	844
June 16	3.83	3,593	August 1	1.57	589
June 23	3.46	3,240	October 6	2.45	1,586
June 28	3.00	2,279			

Daily gage height, in feet, of Jefferson River at Sappington, Montana, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	2.80	3.90	5.00	2.70	1.60	1.50	2.10	2.50	2.50
2	(a)	2.90	3.90	4.90	2.60	1.60	1.50	2.20	2.50	2.50
3	(a)	3.15	4.00	4.80	2.50	1.60	1.50	2.25	2.50	2.50
4	(a)	3.30	4.05	4.90	2.50	1.50	1.50	2.33	2.50	2.50
5	(a)	3.40	4.20	5.00	2.40	1.50	1.60	2.40	2.50	2.60
6	(a)	3.50	4.35	4.00	2.40	1.50	1.60	2.43	2.40	2.60
7	(a)	3.60	4.55	4.90	2.40	1.50	1.60	2.40	2.40	2.60
8	(a)	3.60	4.65	4.90	2.40	1.50	1.60	2.40	2.40	2.60
9	(a)	3.60	4.85	4.70	2.30	1.50	1.60	2.40	2.40	2.60
10	3.00	3.45	5.05	4.60	2.30	1.50	1.70	2.40	2.40	2.60
11	2.80	3.30	5.25	4.50	2.20	1.50	1.70	2.40	2.40	2.60
12	2.80	3.20	5.50	4.20	2.20	1.50	1.70	2.40	2.40	2.50
13	2.80	3.20	6.10	4.00	2.20	1.50	1.70	2.30	2.40	2.50
14	2.70	3.20	6.40	4.00	2.10	1.50	1.70	2.30	2.40	2.50
15	2.70	3.20	6.55	3.90	2.00	1.50	1.70	2.30	2.40	2.50
16	2.70	3.30	6.60	3.80	1.90	1.50	1.70	2.30	2.40	2.50
17	2.60	3.30	6.45	3.90	1.80	1.50	1.70	2.30	2.40	2.40
18	2.70	3.30	6.25	4.00	1.80	1.50	1.80	2.30	2.40	2.40
19	2.80	3.30	6.10	4.10	1.70	1.50	1.85	2.20	2.40	2.40
20	2.80	3.40	5.95	4.20	1.70	1.50	1.90	2.20	2.40	2.40
21	2.90	3.40	5.80	3.90	1.70	1.50	1.90	2.20	2.40	2.40
22	2.90	3.50	5.75	3.65	1.70	1.50	1.90	2.20	2.40	2.40
23	3.00	3.60	5.55	3.30	1.70	1.50	1.90	2.30	2.40	2.40
24	3.10	3.65	5.50	3.20	1.70	1.50	1.90	2.30	2.40	2.40
25	3.10	3.75	5.40	3.10	1.70	1.50	1.90	2.30	2.40	2.40
26	3.10	3.80	5.35	3.00	1.60	1.50	2.00	2.40	2.40	2.40
27	3.05	3.90	5.30	2.90	1.60	1.45	2.00	2.40	2.40	2.40
28	2.95	3.90	5.30	2.85	1.60	1.45	2.00	2.40	2.40	2.30
29	2.80	3.90	5.40	2.80	1.60	1.45	2.00	2.40	2.50	2.30
30	2.70	3.90	5.30	2.80	1.60	1.50	2.00	2.40	2.50	2.30
31	2.70	.....	5.15	.....	1.60	1.50	.....	2.50	.....	2.30

a The river was frozen from January 1 to March 9, inclusive.

MISSOURI RIVER AT TOWNSEND, MONTANA.

Observations of gage heights are maintained at this place by the Missouri River Commission, and the results are furnished to the Geological Survey by the Corps of Engineers, United States Army. The heights given are the means of two daily readings expressed in feet above the St. Louis directrix, which is 412.73 feet above the mean Gulf level. The figures 3,300 have been omitted from the record, so that it is necessary to add that amount to the daily observations to obtain the elevation of the water surface above the St. Louis datum. A description of this station will be found in Water-Supply Paper No. 37, page 208. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 187. During 1900 the following discharge measurements were made under the direction of Samuel Fortier:

Discharge measurements of Missouri River at Townsend, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 28	92.10	15,982	July 17	88.53	2,296
June 15	90.65	8,871	August 14	88.30	1,955
June 22	90.16	7,797	October 12	88.92	3,419
June 29	89.50	4,524			

Daily gage height, in feet, of Missouri River at Townsend, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	90.8	88.8	92.0	89.2	90.4	91.8	89.2	88.2	a88.2	88.7	88.9	90.5
2	93.0	88.8	90.0	89.4	90.5	91.7	89.1	88.2	88.3	88.7	88.9	90.5
3	93.0	88.8	90.0	89.6	90.5	91.7	89.0	88.2	88.3	88.8	88.9	90.3
4	92.9	88.8	93.7	89.6	90.6	91.8	88.9	88.2	88.3	88.8	88.9	90.0
5	92.5	88.8	93.7	89.7	90.6	91.8	88.9	88.2	88.3	88.8	88.9	90.7
6	92.5	88.8	93.7	89.8	90.7	91.8	88.8	88.2	88.4	88.9	88.9	90.0
7	91.5	88.8	93.7	89.8	90.9	91.7	88.8	88.2	88.4	88.9	88.9	89.5
8	91.4	88.8	93.4	89.8	91.2	91.7	88.8	88.2	88.4	88.9	88.9	89.2
9	89.5	88.8	90.4	89.8	91.4	91.7	88.8	88.2	88.4	88.9	88.9	89.0
10	89.5	88.8	90.5	89.8	91.6	91.5	88.7	88.3	88.4	88.9	88.9	88.9
11	89.4	88.8	90.7	89.7	91.8	91.2	88.7	88.3	88.4	88.9	88.9	88.8
12	89.3	88.8	90.5	89.2	92.2	90.9	88.6	88.2	88.4	88.9	88.9	88.7
13	89.1	89.0	90.3	89.5	92.3	90.7	88.4	88.2	88.4	88.9	88.9	88.6
14	89.1	92.3	89.9	89.5	92.4	90.6	88.3	88.2	88.4	88.9	88.9	88.6
15	89.1	92.2	89.5	89.6	92.4	90.5	88.3	88.2	88.4	88.9	88.9	88.6
16	89.1	92.1	89.3	89.7	92.2	90.5	88.3	88.2	88.4	88.9	88.9	88.7
17	89.1	92.1	89.3	89.8	92.2	90.5	88.3	88.2	88.4	88.9	89.0	88.7
18	89.1	92.2	89.3	89.8	92.1	90.5	88.3	88.2	88.4	88.8	89.1	88.6
19	89.1	92.2	89.2	89.8	92.1	90.4	88.3	88.2	88.4	88.8	89.1	88.7
20	89.1	92.3	89.2	89.8	91.9	90.3	88.3	88.2	88.4	88.8	89.1	88.8
21	89.1	92.2	89.3	89.8	91.9	90.2	88.3	88.2	88.4	88.8	89.2	88.9
22	89.1	92.1	89.3	89.9	91.8	90.0	88.3	88.2	88.4	88.8	89.3	88.8
23	89.1	92.1	89.4	90.1	91.7	89.9	88.3	88.2	88.4	88.8	89.6	88.7
24	89.1	92.1	89.4	90.2	91.7	89.8	88.3	88.2	88.4	88.8	89.9	88.7
25	89.1	92.1	89.5	90.3	91.7	89.7	88.3	88.2	88.5	88.8	90.1	88.7
26	89.1	92.1	89.5	90.3	91.7	89.6	88.3	a88.2	88.5	88.8	90.2	88.6
27	89.1	92.1	89.5	90.3	91.8	89.4	88.3	a88.2	88.6	88.8	90.7	88.5
28	89.0	92.1	89.6	90.3	92.1	89.4	88.3	a88.2	88.6	88.9	90.7	88.4
29	89.0	.....	89.5	90.3	92.3	89.3	88.3	a88.2	88.6	88.9	90.7	88.2
30	88.8	.....	89.3	90.3	92.2	89.3	88.3	a88.2	88.6	88.9	90.5	87.9
31	88.8	.....	89.2	.....	92.1	.....	88.3	a88.2	.....	88.9	.....	87.9

a Approximate; no readings received.

CROW CREEK, MONTANA.

Crow Creek, a tributary of Missouri River, is in Jefferson County, Montana. Its headwaters are at an elevation of between 7,000 and 8,000 feet above sea level. It flows in a southeasterly direction for about 25 miles, and empties into Missouri River 33 miles below Toston, at an elevation of about 4,000 feet.

At the foot of the mountains the valley is approximately 12 miles square. About half of it is owned by the residents, and approximately a third of the land owned is being irrigated, though perhaps scantily at times. This leaves without water about 70,000 acres, the greater part of it the choice land of the valley and, according to the farmers who have made efforts in that direction, well adapted to the raising of hay, grain, and fruit crops. The only apparent source of water supply for this vast tract of uncultivated land is small storage reservoirs on Crow Creek, at points along the canyon where the valley widens sufficiently to permit their construction. From the best information obtainable from those familiar with the canyon, the largest of these valleys is from a fourth to a half mile wide and about 2 miles long. On October 13, 1900, the flow of Crow Creek at the mouth of the canyon, 5 miles above Radersburg, Montana, was, by actual measurement, 16 second-feet. On the same date the discharge at the bridge 1 mile below the canyon was also 16 second-feet. The high-water flow lasts from four to six weeks, with an occasional summer flood, and is confined in a channel having an average width of from 25 to 30

feet, with vertical banks of from 4 to 5 feet on either side, and a fall of 58.7 feet to the mile.

MILK RIVER AT HAVRE, MONTANA.

This station, which was established by C. C. Babb on May 15, 1898, is described in Water-Supply Paper No. 37, page 209. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 189. During 1900 the following measurements of discharge were made by C. W. Ling:

Discharge measurements of Milk River at Havre, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 21	2.90	242	August 4	1.40	12
April 26	3.30	327	August 11	1.40	13
April 27	3.00	302	August 13	2.60	182
Do	3.07	314	August 14	2.40	145
May 3	3.20	390	August 20	1.60	27
May 7	2.70	309	August 31	1.60	27
May 11	2.40	207	September 4	1.50	23
May 15	2.60	260	September 5	1.70	48
May 16	4.00	863	September 8	2.00	80
May 17	5.20	1,651	September 10	2.50	142
May 18	4.50	1,112	September 17	1.90	50
May 24	3.40	444	September 22	2.20	97
May 31	3.00	312	October 2	2.00	84
June 9	2.60	185	October 6	3.10	314
June 12	2.40	142	October 8	2.90	236
June 21	2.20	117	October 12	2.60	157
June 27	2.10	108	October 16	2.90	265
July 3	1.90	76	October 22	2.40	129
July 10	2.00	92	October 27	2.30	114
July 18	1.70	30	November 2	2.30	96
July 25	1.50	14	November 10	2.00	63
August 3	1.40	17			

Daily gage height, in feet, of Milk River at Havre, Montana, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.10	3.10	2.00	1.50	1.60	2.00	2.30	(a)
2	.....	3.30	3.00	2.00	1.40	1.50	2.00	2.30	(a)
3	.....	3.20	2.90	1.90	1.40	1.50	2.10	2.30	(a)
4	.....	3.00	2.70	1.90	1.40	1.50	2.20	2.20	(a)
5	.....	2.90	2.70	1.90	1.40	1.70	2.40	2.20	(a)
6	.....	2.80	2.70	1.90	1.40	1.70	3.10	2.20	(a)
7	.....	2.70	2.70	1.80	1.40	1.80	3.10	2.20	(a)
8	.....	2.60	2.60	1.80	1.30	2.00	2.90	2.20	(a)
9	.....	2.60	2.60	1.90	1.30	2.10	2.80	2.20	(a)
10	3.40	2.50	2.40	2.00	1.30	2.50	2.70	2.00	(a)
11	3.40	2.40	2.40	2.10	1.40	2.40	2.60	1.90	(a)
12	3.70	2.30	2.40	1.80	2.75	2.40	2.60	2.20	(a)
13	3.60	2.40	2.30	1.80	2.65	2.40	2.50	2.40	(a)
14	3.60	2.40	2.30	1.70	2.40	2.00	2.50	2.20	(a)
15	3.40	2.60	2.30	1.70	2.20	2.00	2.80	2.50	(a)
16	3.30	4.00	2.30	1.70	2.00	1.90	2.90	(a)	(a)
17	3.00	5.10	2.30	1.70	1.90	1.90	3.00	(a)	1.40
18	3.20	4.60	2.40	1.70	1.70	1.90	2.90	(a)	1.40
19	2.90	4.10	2.20	1.60	1.60	1.90	2.80	(a)	1.40
20	2.90	3.70	2.20	1.60	1.60	1.90	2.70	(a)	1.40
21	2.90	3.60	2.20	1.60	1.50	2.00	2.70	(a)	1.40
22	2.90	3.90	2.20	1.60	1.50	2.20	2.40	(a)	1.60
23	2.90	3.60	2.20	1.50	1.40	2.20	2.40	(a)	(a)
24	3.10	3.40	2.10	1.50	1.40	2.10	2.30	(a)	(a)
25	3.30	3.30	2.10	1.50	1.40	2.00	2.30	(a)	(a)
26	3.30	3.20	2.20	1.50	1.40	2.00	2.30	(a)	(a)
27	2.90	3.10	2.10	1.50	1.40	2.00	2.30	(a)	(a)
28	3.10	2.90	2.10	1.60	1.40	1.90	2.30	(a)	(a)
29	2.90	3.00	2.10	1.50	1.40	1.90	2.30	(a)	(a)
30	3.00	2.90	2.00	1.50	1.40	2.00	2.20	(a)	(a)
31	.....	3.00	.....	1.50	1.60	.....	2.20	.....	(a)

a Frozen.

YELLOWSTONE RIVER NEAR LIVINGSTON, MONTANA.

This station, which was established May 2, 1897, is located at the highway bridge over the Yellowstone 5 miles south of Livingston. It is described in Water-Supply Paper No. 37, pages 210 and 211, where will also be found the results of measurements for 1899. During 1900 the following measurements were made under the direction of Samuel Fortier:

Discharge measurements of Yellowstone River near Livingston, Montana.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 25	3.08	7,917	July 14	1.76	4,623
Do	3.15	8,482	August 7	.75	3,160
June 14	4.30	13,552	September 29	−.45	1,710
June 21	4.08	11,835	October 17	−.60	1,599
June 27	3.40	9,094			

Daily gage height, in feet, of Yellowstone River near Livingston, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	(a)	.....	−1.00	0.30	3.80	2.80	0.95	−0.05	−0.45	−0.70	−0.95
2	.....	(a)	.....	−.90	.60	4.00	2.68	.90	−.05	−.43	−.70	−.88
3	.....	(a)	.....	−.80	.75	4.20	2.55	.88	−.10	−.40	−.70	−.90
4	.....	(a)	.....	−.70	1.40	4.30	2.50	.80	−.10	−.43	−.70	−.90
5	.....	(a)	.....	−.70	1.75	4.35	2.40	.75	−.10	−.45	−.70	−.90
6	−0.85	(a)	(a)	−.70	2.30	4.70	2.30	.75	−.10	−.45	−.70	−.90
7	.....	(a)	(a)	−.50	2.20	4.75	2.23	.70	−.15	−.45	−.73	−.90
8	.....	(a)	(a)	−.20	2.15	4.38	2.13	.70	−.15	−.48	−.75	−.90
9	.....	(a)	(a)	−.30	2.67	4.60	2.10	.65	−.20	−.50	−.75	−.90
10	.....	(a)	(a)	−.60	3.35	3.95	2.03	.60	−.20	−.53	−.80	−.90
11	.....	(a)	(a)	−.60	3.73	3.85	1.95	.55	−.25	−.55	−.88	−.90
12	.....	(a)	(a)	−.60	4.00	3.75	1.88	.50	−.25	−.60	−.90	−.90
13	−0.80	(a)	(a)	−.60	3.40	3.70	1.80	.50	−.25	−.60	−.83	−1.10
14	.....	(a)	−0.90	−.55	2.78	4.05	1.73	.45	−.25	−.60	−.80	−1.00
15	.....	(a)	.....	−.55	2.30	4.25	1.70	.45	−.30	−.65	−.85	−1.00
16	.....	(a)	.....	−.60	2.28	4.20	1.68	.40	−.33	−.60	−.75	−1.00
17	.....	(a)	.....	−.60	2.48	4.13	1.55	.35	−.35	−.60	−.83	−1.00
18	.....	(a)	.....	−.60	2.40	3.90	1.53	.30	−.35	−.60	−.95	−1.00
19	.....	(a)	.....	−.50	2.17	3.80	1.50	.30	−.30	−.60	(a)	−1.00
20	−0.90	(a)	.....	−.20	2.25	3.90	1.45	.25	−.30	−.65	(a)	−1.00
21	.....	−0.90	−1.00	.00	2.38	3.90	1.40	.25	−.35	−.60	(a)	−1.00
22	.....	.....	.....	.20	2.55	3.95	1.38	.25	−.35	−.65	(a)	−1.00
23	.....	.....	.....	.65	2.73	3.88	1.30	.20	−.40	−.60	(a)	.....
24	.....	.....	.....	.40	2.90	3.73	1.25	.20	−.40	−.60	−1.10	−1.20
25	.....	.....	.....	.40	3.03	3.68	1.20	.20	−.40	−.65	−1.08	−1.10
26	.....	.....	.....	.30	3.65	3.60	1.20	.20	−.43	−.65	−.90	−1.15
27	.....	−0.90	.....	.20	4.20	3.43	1.20	.15	−.45	−.65	−.85	−1.15
28	.....	.....	.....	.30	4.65	3.23	1.15	.15	−.45	−.65	−.90	−1.35
29	.....	.....	.....	.40	4.38	3.10	1.10	.10	−.45	−.65	−1.00	−1.35
30	.....	.....	.....	.35	3.98	3.03	1.05	.05	−.45	−.70	−1.00	.....
31	.....	.....	−1.00	.....	3.80	.....	1.00	.00	.....	−.70	.....	(a)

a Frozen.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN MONTANA.

During the year the following miscellaneous measurements of streams in Montana were made by Messrs. F. E. and G. H. Matthes:

Miscellaneous discharge measurements of streams in Montana.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
June 18	St. Mary River	Main	F. E. Matthes.	2,294
August 6	do	do	G. H. Matthes.	750
October 14	do	do	do	552
June 16	do	Outlet of Lower Lake	F. E. Matthes.	750
June 19	North Fork of Milk River.	Bridge at Hall's ranch	do	12
June 21	Middle Fork of Milk River	Ford of road to Main	do	7
June 14	South Fork of Milk River.	Paul's ranch	do	31
June 8	Cutbank River	Ford of road to St. Mary Lake.	do	488
June 9	North Fork of Cutbank River.	Base of mountains	do	231
June 7	Two Medicine River	Outlet of Lower Lake	do	390
May 23	do	Holy Family Mission	do	1,067
May 29	do	Ford 12 miles below Piegan.	do	1,261
May 28	Badger Creek	Two miles above Piegan	do	562
May 24	do	Ford at Piegan	do	273
May 26	Birch Creek	Four miles above Robare	do	387
Do	do	One-half mile above Robare.	do	302

BIGHORN RIVER NEAR THERMOPOLIS, WYOMING.

This station, which was established by A. J. Parshall on May 28, 1900, is located about a half mile west of Thermopolis, at the ferry crossing the river. The gage, which consists of a horizontal rod extending out over the water, is fastened to a post set firmly in the bank. On the horizontal stick is attached the wire gage by means of which the heights of the river are recorded. The bench mark is the head of a nail in a stick driven in the ground 1 foot south of the post to which the gage rod is fastened and 2.58 feet below the top of the gage frame. The bench mark is 9.08 feet above gage datum. Discharge measurements have been made from a ferryboat, but during the coming season they will be made from the bridge which has recently been erected. The channel is straight for a distance above and below the station. Both banks are high and not subject to overflow. The bed of the stream is of gravel, and shifts during only extreme high water. Results of measurements for 1899 will be found in Water-Supply Paper No. 37, page 211. During 1900 the following discharge measurements were made by A. J. Parshall:

May 28: Gage height, 4.01 feet; discharge, 8,500 second-feet.
May 29: Gage height, 5.00 feet; discharge, 10,527 second-feet.
May 30: Gage height, 5.40 feet; discharge, 12,187 second-feet.
September 13: Gage height, 0.60 foot; discharge, 945 second-feet.
September 18: Gage height, 0.45 foot; discharge, 674 second-feet.

Daily gage height, in feet, of Bighorn River near Thermopolis, Wyoming, for 1900.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	4.00	3.40	1.55	1.20	12	5.20	2.65	1.50	0.70	23	4.10	1.60	1.40	.....
2	4.30	3.30	1.50	1.20	13	4.65	2.55	1.50	.60	24	4.45	1.60	1.30	.....
3	4.45	3.30	1.50	1.10	14	4.30	2.45	1.50	.55	25	4.50	1.60	1.30	.....
4	5.00	3.20	1.50	1.00	15	4.10	2.25	1.50	.50	26	5.00	1.60	1.30	.....
5	4.85	3.20	1.80	1.00	16	4.00	2.20	1.50	.....	27	5.25	1.60	1.30	.....
6	4.80	3.10	1.50	.90	17	3.80	2.20	1.50	.....	28	5.00	1.50	1.30	.....
7	5.70	3.20	1.50	.90	18	3.60	2.10	1.80	.....	29	4.25	1.50	1.20	.....
8	6.60	3.15	1.50	.90	19	3.50	2.05	1.40	.....	30	3.50	1.50	1.20	.....
9	5.90	3.00	1.50	.90	20	3.50	1.95	1.40	.....	31	.....	1.60	1.20	.....
10	5.85	2.80	1.50	.90	21	3.50	1.70	1.30	.....					
11	5.45	2.80	1.50	.70	22	3.90	1.60	1.30	.....					

CLEAR CREEK NEAR BUFFALO, WYOMING.

This station was established by the State engineer of Wyoming. A measuring flume was erected in order that accurate measurements of discharge might be obtained. Owing to the stability of the station it has not been necessary to make discharge measurements at this place, the computations being made from the rating table established several years ago. The station is described in Water-Supply Paper No. 37, page 212. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 191. Owing to the diversions of water which have taken place within the basin, of late years this station has not been considered as important as formerly, and it was discontinued on March 11, 1900, no measurements of discharge being made during that year.

Daily gage height, in feet, of Clear Creek near Buffalo, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	0.40	0.30	0.30	12	0.35	0.30	.....	23	0.30	0.30	.....
2	.40	.30	.30	13	.35	.30	.....	24	.30	.30	.....
3	.40	.30	.30	14	.35	.30	.....	25	.30	.30	.....
4	.37	.30	.30	15	.35	.30	.....	26	.30	.30	.....
5	.37	.30	.....	16	.32	.30	.....	27	.30	.30	.....
6	.37	.30	.....	17	.32	.30	.....	28	.30	.30	.....
7	.35	.30	.35	18	.32	.30	.....	29	.30	.....	.....
8	.35	.30	.....	19	.30	.30	.....	30	.30	.....	.....
9	.35	.30	.....	20	.30	.30	.....	31	.30	.....	.....
10	.35	.30	.35	21	.30	.30	.....				
11	.35	.30	.....	22	.30	.30	.....				

BIG SIOUX RIVER NEAR WATERTOWN, SOUTH DAKOTA.

Big Sioux River rises in Grant County, South Dakota, about 30 miles north of Watertown. Its principal headwaters drain lands constituting part of the Sisseton and Wahpeton Indian Reservation. Its general course is southeast, and it empties into Missouri River near Sioux City, Iowa. The river is of interest on account of its water powers, a number of which have been developed, principally at Flandreau, Dell Rapids, and Sioux Falls, South Dakota, and at Akron, Iowa. The gaging station was established by O. V. P. Stout, the gage being put in September 15, 1900, by George W. Carpenter, county surveyor for Codington County. It is located on the farm of L. E. Spicer, about 4 miles above Watertown. The gage consists of an inclined rod securely fastened on the right bank of the stream. The observer is L. E. Spicer. During 1900 the following discharge measurements were made by O. V. P. Stout and G. H. Matthes:

July 17: Discharge, 5 second-feet.
July 18: Discharge, 10 second-feet.
November 12: Gage height, 1.15 feet; discharge, 7 second-feet.

The measurement of July 18 was not made at the gaging station, but in the town.

Lake Poinsett, which lies almost wholly in Hamlin County, South Dakota, has its outlet in Big Sioux River near Dempster, a short distance above Estelline. Immediately below the outlet of the lake a dam has been constructed on the Big Sioux to maintain the level of the lake within certain limits. A measurement of the inlet to the lake was made July 19, 1900, by O. V. P. Stout, and a discharge of 16.5 second-feet was found.

Big Sioux River at the bridge west of Estelline was also measured by Mr. Stout on July 19, 1900, and a discharge of 16.9 second-feet was found.

Daily gage height, in feet, of Big Sioux River near Watertown, South Dakota, for 1900

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	12	.....	1.25	.....	.....	23	1.30	1.25	1.20	1.20
2	.....	1.30	1.25	1.20	13	.....	.....	1.15	.....	24	.....	.....	.....	.....
3	.....	.....	.....	.....	14	.....	1.25	.....	1.20	25	1.30	.....	1.20	1.20
4	.....	.....	1.25	1.20	15	.....	.....	.....	.....	26	.....	1.25	.....	.....
5	.....	1.25	.....	.....	16	1.40	1.25	1.15	1.20	27	.....	.....	1.20	.....
6	.....	.....	1.20	.....	17	.....	.....	.....	.....	28	1.30	1.25	.....	1.15
7	.....	1.25	.....	1.20	18	1.30	.....	1.20	1.20	29	.....	.....	.....	.....
8	.....	.....	.....	.....	19	.....	1.25	.....	.....	30	1.30	1.25	1.20	1.15
9	.....	1.25	1.15	1.20	20	.....	.....	1.20	.....	31	.....	.....	.....	.....
10	.....	.....	.....	.....	21	1.30	1.25	.....	1.20					
11	.....	.....	1.15	1.20	22	.....	.....	.....	.....					

BIG SIOUX RIVER NEAR SIOUX FALLS, SOUTH DAKOTA.

This gaging station, which was established by O. V. P. Stout on July 21, 1900, is 2 miles west of Sioux Falls. The gage consists of an inclined rod securely fastened to bevel blocks supported on well-bedded cross-ties. The observer is George Beggs. During 1900 the following discharge measurement was made by O. V. P. Stout:

July 21: Gage height, 2.02 feet; discharge, 78 second-feet.

Daily gage height, in feet, of Big Sioux River near Sioux Falls, South Dakota, for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Day.	Aug.	Sept.	Oct.	Nov.	Day.	Aug.	Sept.	Oct.	Nov.
1	.....	1.20	1.60	1.80	12	1.40	1.40	1.70	1.80	22	1.30	1.40	1.20	.....
2	.....	1.20	1.80	1.80	13	1.50	1.40	1.70	1.80	23	1.30	1.60	1.10	.....
3	.....	1.20	1.80	1.80	14	1.50	1.30	1.70	1.80	24	1.50	1.60	1.10	.....
4	.....	1.20	1.80	1.80	15	1.40	1.50	1.70	1.70	25	1.40	1.60	1.10	.....
5	.....	1.10	1.80	1.80	16	1.40	1.40	1.70	1.70	26	1.40	1.60	1.90	.....
6	.....	1.30	1.80	1.80	17	1.30	1.40	1.70	1.70	27	1.30	1.50	1.80	.....
7	.....	1.20	1.70	1.80	18	1.40	1.50	1.70	.....	28	1.30	1.50	1.80	.....
8	.....	1.20	1.70	1.70	19	1.40	1.50	1.70	.....	29	1.30	1.70	1.80	.....
9	.....	1.20	1.70	1.70	20	1.30	1.50	1.70	.....	30	1.30	1.60	1.90	.....
10	1.40	1.30	1.70	1.80	21	1.30	1.40	1.90	.....	31	1.30	.....	1.90	.....
11	1.40	1.40	1.70	1.80										

MISCELLANEOUS DISCHARGE MEASUREMENTS OF CHEYENNE RIVER AND ITS TRIBUTARIES.

During the year a number of measurements of Cheyenne River and its tributaries were made by J. T. Stewart, as described in the table on the next page.

Miscellaneous discharge measurements of Cheyenne River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-feet.*
May 14	Cheyenne River	Edgemont, S. Dak	John T. Stewart	14.6
May 17	do	do	do	10.3
May 29	do	do	do	.5
May 18	do	Above mouth of Cascade Creek	do	12.2
June 12	do	do	do	.7
May 19	do	Above mouth of Fall River	do	39.2
June 4	do	Mouth of Fall River	do	18.7
May 21	do	Below mouth of Beaver Creek, 7 miles southeast of Buffalo Gap, S. Dak.	do	47.4
June 5	do	Below mouth of Beaver Creek	do	49.0
May 15	Salt Creek	East of Newcastle, Wyo	do	.2
May 31	do	do	do	.2
May 15	Big Oil Creek	B. and M. Railway bridge	do	.2
May 29	do	do	do	.03
May 17	Little Oil Creek	Newcastle, Wyo	do	.05
May 29	do	do	do	.02
May 18	Cascade Creek	At mouth	do	24.6
June 2	do	do	do	19.9
Do	Hat Creek	do	do	.0
May 19	Fall River	Below Hot Springs, S. Dak	do	24.7
June 4	do	Hot Springs, S. Dak	do	28.6
May 19	do	At mouth	do	33.3
June 4	do	do	do	24.8
May 26	Iron Creek	Glendale, S. Dak	do	3.8
June 7	do	do	do	1.6
May 15	Stockade Beaver Creek.	Two miles above L. A. K. ranch, Wyo.	do	11.1
May 31	do	do	do	11.8
May 16	do	At mouth	do	9.4
May 30	do	do	do	3.5
May 15	Beaver Creek	Above mouth of Stockade Beaver Creek.	do	.0
May 30	do	do	do	.0
May 21	do	Three miles northwest of Buffalo Gap, S. Dak.	do	12.2
June 5	do	do	do	14.6
May 21	do	At mouth, 7 miles southeast of Buffalo Gap.	do	1.2
June 5	do	At mouth	do	6.0
May 21	Lame Johnny Creek	Seven miles northeast of Buffalo Gap.	do	.0
Do	do	East of Buffalo Gap	do	.0
May 28	French Creek	Custer, S. Dak	do	.0
May 22	do	Ten miles above Fairburn, S. Dak	do	12.8
June 6	do	Ten miles northeast of Fairburn, S. Dak.	do	4.9
May 22	do	Fairburn, S. Dak	do	3.3
June 7	do	do	do	.2
May 22	Squaw Creek	Otis, S. Dak	do	7.9
June 6	do	do	do	2.8
May 26	Battle Creek	Keystone, S. Dak	do	3.1
June 7	do	do	do	2.3
May 25	do	Hermosa, S. Dak	do	9.1
June 8	do	do	do	2.3
May 24	Spring Creek	North of Rockerville, S. Dak	do	6.5
June 9	do	do	do	.7
May 23	do	F. E. and M. V. Railway bridge, S. Dak.	do	.4
June 9	do	do	do	.1
May 24	Rapid Creek	Five and one-half miles above Rapid City, S. Dak.	do	48.8
June 8	do	do	do	26.3
May 25	do	Rapid City, S. Dak	do	64.2
June 8	do	do	do	29.9

NORTH PLATTE RIVER.

This river has its source in the mountains of North Park, in northern Colorado. Upon entering Wyoming the stream passes through a short, narrow canyon, and then flows northerly through the upper Platte Valley, which extends from the State line down to Fort Steele. On August 27, 1900, A. J. Parshall made measurements of the river

at two points in its upper reaches. The first measurement was made a short distance above the mouth of Grand Encampment Creek and immediately above the mouth of Brush Creek, and a discharge of 176 second-feet was found. The second measurement was made near Saratoga, Wyoming, immediately above the mouth of Spring Creek, and a discharge of 211 second-feet was found.

GRAND ENCAMPMENT CREEK AT PERYAM'S RANCH, WYOMING.

This station, which was established by A. J. Parshall May 16, 1900, is located at the bridge over the river at the ranch of the observer, W. T. Peryam. The rod is vertical, and is fastened to the timbers of the bridge. The channel is straight for a distance above and below the station. The right bank is high and is not subject to overflow, but the left bank is low and overflows at high stages. The bed of the stream is rocky. During 1900 the following measurements were made by A. J. Parshall:

May 16: Gage height, 2.00 feet; discharge, 2,050 second-feet.
June 8: Gage height, 2.00 feet; discharge, 2,184 second-feet.
June 21: Gage height, 1.20 feet; discharge, 885 second-feet.
July 5: Gage height, 0.60 foot; discharge, 192 second-feet.
July 18: Gage height, 0.30 foot; discharge, 39 second-feet.

Daily gage height, in feet, of Grand Encampment Creek at Peryam's ranch, Wyoming, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1		2.70	0.95	0.50	0.25	17	1.90	1.60	0.40	0.40	0.40
2		2.60	.75	.50	.25	18	2.05	1.50	.40	.40	.30
3		2.40	.75	.45	.20	19	1.90	1.50	.30	.30	.30
4		2.30	.65	.45	.20	20	1.70	1.30	.30	.30	.30
5		2.25	.60	.40	.25	21	1.80	1.20	.30	.30	.30
6		2.30	.60	.40	.25	22	1.90	1.20	.35	.30	.30
7		2.20	.60	.40	.30	23	2.30	1.30	.35	.30	.40
8		2.05	.60	.50	.30	24	2.10	1.20	.40	.30	.40
9		2.20	.60	.50	.30	25	2.40	1.20	.40	.40	.50
10		2.25	.60	.50	.30	26	2.50	1.10	.40	.50	.50
11		2.10	.60	.50	.30	27	2.90	1.00	.40	.50	.00
12		1.90	.60	.45	.30	28	3.00	1.15	.45	.35	.50
13		1.90	.50	.45	.30	29	3.20	1.00	.50	.30	.50
14		1.70	.50	.45	.35	30	3.00	1.00	.50	.30	.50
15		1.60	.45	.40	.40	31	3.00		.50	.27	
16	2.00	1.70	.45	.40	.40						

LARAMIE RIVER AT WOODS, WYOMING.

This station, which was established in December, 1888, by the Territorial engineer of Wyoming, is located 26 miles from Laramie, and is reached by stage. It is described in Water-Supply Paper No. 37, page 214. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 193. The station was discontinued September 30, 1900. During the year one measurement ment of discharge was made by A. J. Parshall, as follows:

May 4: Gage height, 1.60 feet; discharge, 460 second-feet.

Daily gage height, in feet, of Laramie River at Woods, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Ju .	Aug.	Sept.
1				0.70	1.40	4.15	1.40	0.60	0.30
2				.70	1.40	4.05	1.30	.60	.30
3				.70	1.50	3.90	1.30	.60	.30
4				.80	1.55	3.80	1.20	.60	.30
5				.80	1.60	3.70	1.15	.70	.30
6				.65	1.80	3.60	1.10	.70	.30
7	1.10	1.20	1.30	.80	2.00	3.45	1.00	.65	.30
8				.80	2.00	3.45	1.00	.60	.35
9				.70	2.25	3.45	1.00	.60	.50
10				.70	2.55	3.45	1.00	.60	.55
11				.70	2.75	3.40	.95	.50	.45
12				.60	3.00	3.25	.90	.50	.35
13				.60	3.00	2.95	.90	.50	.40
14	1.20	1.20	1.20	.60	2.95	2.75	.80	.50	.40
15				.60	2.65	2.65	.80	.50	.40
16				.50	2.95	2.55	.80	.50	.35
17				.60	3.05	2.45	.80	.40	.30
18				.60	3.15	2.45	.80	.40	.30
19				.75	3.05	2.35	.80	.40	.40
20				.95	3.00	2.25	.80	.40	.40
21	1.20	1.30	1.00	1.30	2.95	2.10	.70	.40	.40
22				1.35	2.85	2.10	.70	.35	.40
23				1.20	3.15	1.95	.70	.30	.45
24				1.10	3.25	1.85	.70	.30	.40
25				1.00	3.45	1.75	.70	.30	.40
26				1.00	3.75	1.65	.60	.30	.40
27				1.15	3.95	1.55	.60	.30	.40
28	1.10	1.20	1.00	1.45	4.05	1.50	.60	.30	.45
29				1.55	4.15	1.40	.60	.30	.50
30				1.45	4.25	1.40	.60	.30	.50
31					4.30		.60	.30	

LARAMIE RIVER NEAR UVA, WYOMING.

This station was established in 1894 by the State engineer of Wyoming. It is described in Water-Supply Paper No. 37, page 216. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 194. The station was discontinued March 31, 1900, and no measurements of discharge were made during the year.

Daily gage height, in feet, of Laramie River near Uva, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1				12				23			
2			1.6	13	1.4			24		1.5	2.1
3		1.6		14				25			
4				15				26			
5				16				27	1.5		
6	1.6			17		1.6	2.3	28			
7				18				29			
8				19	1.4			30			
9				20				31			1.9
10		1.7	1.8	21							
11				22							

NORTH PLATTE RIVER AT ORIN JUNCTION, WYOMING.

This station was established November 1, 1894, by the State engineer of Wyoming. It is described in Water-Supply Paper No. 37, page 217. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 196. The station was discontinued April 1, 1900, and no measurements of discharge were made during the year.

Daily gage height, in feet, of North Platte River at Orin Junction, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1				2.3	12			1.3		23				
2					13					24		2.2	1.7	
3		1.5	2.2		14					25				
4					15	(a)				26				
5					16					27				
6					17		2.2	2.5		28				
7					18					29	(a)			
8	(a)				19					30				
9					20					31				
10		1.5			21									
11					22	(a)								

a Frozen.

NORTH PLATTE RIVER NEAR GUERNSEY, WYOMING.

This station was established June 14, 1900, by A. J. Parshall. It is located at the county bridge about a half mile northwest of Guernsey. The bridge has eight piers, the sides are planked, and there is uniform flow under each span. The location is an excellent one for accurate measurements. The rod consists of a 4-inch by 4-inch by 12-foot scantling firmly attached to one of the piers of the bridge. As the station was to be a temporary one, a metallic tape, divided into feet and tenths, was securely fastened to the rod. The bench mark is a spike driven in a sleeper of the bridge 1 foot from the rod and at an elevation of 10.04 feet above the zero. The channel is straight for a distance above and below the station. Both banks are high and do not overflow at high stages. The bed of the stream is sandy, but probably does not shift much. The station was discontinued September 15, 1900. During 1900 the following measurements were made by A. J. Parshall:

June 14: Gage height, 4.40 feet; discharge, 9,792 second-feet.
June 26: Gage height, 2.40 feet; discharge, 5,018 second-feet.
July 10: Gage height, 0.50 foot; discharge, 1,805 second-feet.
July 13: Gage height, 0.25 foot; discharge, 1,876 second-feet.
August 2: Gage height, —0.20 foot; discharge, 778 second-feet.
August 21: Gage height, —0.70 foot; discharge, 430 second-feet.

Daily gage height, in feet, of North Platte River near Guernsey, Wyoming, for 1900.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1			—0.20	—0.90	17		.40	— .70	
2		1.50	— .20		18	3.40	1.10	— .80	
3		1.30	— .25	— .90	19	3.40	.75		
4		1.20	— .25	— .90	20	3.20	.25	— .90	
5		1.00		— .90	21	3.00	.10	— .80	
6		.90	— .30	— .95	22	2.85		— .70	
7		.80	— .30	— .95	23	2.70	.00	— .70	
8			— .40	— .95	24		.05	— .75	
9		.60	— .40		25	2.50	.10	— .80	
10		.50	— .60	— .95	26	2.40	.00		
11		.40	— .60	— .95	27	2.30	.10	— .80	
12		.30		— .95	28	2.20	.05	— .90	
13		.25	— .70	— .95	29	2.00		— .90	
14	4.40	.20	— .70	— .95	30	1.90	.15	— .90	
15	4.20		— .70	— .95	31		.10	— .90	
16	3.90	.70	— .70						

NORTH PLATTE RIVER AT GERING, NEBRASKA.

This station, which was established May 29, 1897, is located at the highway bridge at Gering. It is described in Water-Supply Paper No. 37, page 218. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 197. During 1900 the following measurements of discharge were made by R. H. Willis:

Discharge measurements of North Platte River at Gering, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 18	1.67	5,251	August 1	1.15	1,152
April 27	1.90	7,138	August 10	1.02	848
May 11	2.16	10,980	August 22	.93	529
May 23	2.46	10,909	August 30	.84	395
May 30	2.65	12,371	September 11	.96	385
June 12	2.86	13,706	September 20	.85	356
June 21	2.24	9,231	October 19	.32	486
June 28	1.80	6,321	October 20	.35	399
July 9	1.45	2,874	October 30	.45	522
July 19	1.55	3,947			

Daily gage height, in feet, of North Platte River at Gering, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		2.25	2.75	1.70	1.00	0.78	0.48	0.35
2		2.20	2.80	1.70	1.00	.77	.35	.36
3		2.25	2.90	1.71	1.02	.78	.33	.36
4		2.40	2.98	1.70	1.00	.79	.27	.37
5		2.35	2.85	1.60	1.01	.76	.27	.39
6		2.35	2.85	1.53	1.00	.77	.26	.40
7		2.20	2.82	1.53	.97	.73	.27	.41
8		2.15	2.80	1.44	.98	.76	.27	.40
9		2.15	2.78	1.44	.95	.75	.27	.42
10		2.05		1.40	.96	.80	.26	1.05
11		2.15		1.30	.95	.85	.25	1.04
12		2.16	2.71	1.21	.93	.87	.23	1.03
13		2.30	2.71	1.10	.90	.90	.24	1.04
14		2.36	2.86	1.12	.90	.90	.24	a 1.05
15		2.53	2.76	1.29	.86	.90	.23	
16		2.62	2.56	1.21	.90	.85	.24	
17		2.65	2.46	1.30	.90	.80	.24	
18	1.67	2.56	2.29	1.30	.90	.80	.23	
19	1.60	2.50	2.23	1.56	.88	.77	.32	
20	1.55	2.45	2.26	1.42	.88	.75	.31	
21	1.55	2.46	2.19	1.25	.88	.75	.31	
22	1.60	2.49	2.01	1.30	.84	.75	.30	
23	1.85	2.40	1.89	1.22	.82	.75	.30	
24	1.90	2.35	1.89	1.30	.80	.75	.31	
25	1.83	2.31	1.91	1.40	.71	.60	.31	
26	1.80	2.29	1.87	1.21	.73	.62	.32	
27	1.90	2.35	1.81	1.21	.76	.60	.33	
28	2.00	2.50	1.80	1.19	.75	.61	.34	
29	2.00	2.53	1.76	1.01	.74	.55	.34	
30	2.40	2.60	1.70	1.05	.75	.53	.36	
31		2.69		1.05	.75		.37	

a Closed for winter November 14.

NORTH PLATTE RIVER AT CAMP CLARKE, NEBRASKA.

This station, which was established June 27, 1896, consists of a timber fastened to cross-ties bedded in the bank of the river. It is described in Water-Supply Paper No. 37, page 219. Results of

measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 198. During 1900 the following discharge measurements were made by R. H. Willis:

Discharge measurements of North Platte River at Camp Clarke, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 19	3.28	4,928	July 28	2.61	1,624
April 28	3.71	7,146	August 11	2.20	501
May 14	4.10	11,838	August 24	2.05	421
May 25	2.90	9,131	August 31	1.96	274
May 31	4.08	10,434	September 12	2.08	320
June 13	4.27	11,334	September 21	2.08	246
June 22	3.75	7,695	October 3	2.10	234
June 29	3.35	4,049	October 20	2.18	377
July 11	2.74	2,116	October 31	2.26	610
July 20	3.08	3,654			

Daily gage height, in feet, of North Platte River at Camp Clarke, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	4.10	4.29	3.31	2.25	1.98	2.10	2.23
2	.....	3.85	4.31	3.27	2.33	1.92	2.05	2.23
3	.....	3.85	4.45	3.21	2.30	1.95	2.09	2.22
4	.....	4.05	4.49	3.15	2.38	1.96	2.08	2.24
5	.....	4.00	4.52	3.06	2.23	2.02	2.07	2.24
6	.....	3.98	4.52	2.95	2.24	1.97	2.15	2.25
7	.....	3.89	4.48	2.91	2.26	1.98	2.11	2.26
8	2.90	3.92	4.43	2.71	2.20	1.93	2.10	2.28
9	3.03	3.84	4.48	2.70	2.20	2.03	2.10	2.30
10	3.23	3.94	4.42	2.73	2.20	2.08	2.08	a 2.31
11	3.20	3.92	4.34	2.71	2.16	2.10	2.09	.....
12	3.27	3.99	4.38	2.62	2.15	2.09	2.11	.....
13	3.16	4.02	4.27	2.62	2.15	1.96	2.14	.....
14	3.28	4.10	4.25	2.62	2.15	1.98	2.16	.....
15	3.42	4.19	4.28	2.74	2.11	2.05	2.18	.....
16	3.35	4.27	4.17	2.72	2.11	2.02	2.15	.....
17	3.20	4.34	4.10	2.62	2.10	2.05	2.15	.....
18	3.30	4.23	3.90	2.73	2.07	2.07	2.16	.....
19	3.24	4.12	3.89	2.68	2.05	2.04	2.18	.....
20	3.22	4.05	3.84	3.05	2.07	2.01	2.19	.....
21	3.21	4.07	3.81	2.83	2.05	2.03	2.20	.....
22	3.26	4.09	3.75	2.77	2.03	2.02	2.21	.....
23	3.57	4.05	3.51	2.78	2.06	2.01	2.20	.....
24	3.57	3.91	3.52	2.83	2.03	2.15	2.20	.....
25	3.59	3.90	3.48	2.62	2.01	2.19	2.21	.....
26	3.48	3.82	3.43	2.70	2.00	2.20	2.21	.....
27	3.57	3.78	3.39	2.59	1.90	2.15	2.22	.....
28	3.71	3.91	3.42	2.59	1.90	2.15	2.21	.....
29	3.89	4.01	3.33	2.50	1.93	2.14	2.23	.....
30	3.79	4.11	3.31	2.40	1.95	2.10	2.25	.....
31	.....	4.15	.....	2.32	1.99	.....	2.25	.....

a Closed for winter.

NORTH PLATTE RIVER AT NORTH PLATTE, NEBRASKA.

This station, which was established in 1894, is 3.5 miles above the junction of South Platte River. It is described in Water-Supply Paper No. 37, page 220. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 199. During 1900 one discharge measurement was made by Adna Dobson, as follows:

December 20: Gage height, 2.30 feet; discharge, 1,223 second-feet.

Daily gage height, in feet, of North Platte River at North Platte, Nebraska, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	2.00	2.70	2.30	3.20	3.45	2.85	1.85	0.80	1.40	1.80	2.10
2	2.35	2.05	2.85	2.30	3.15	3.50	2.60	1.75	.80	1.40	1.80	2.20
3	2.20	2.20	3.00	2.20	3.35	3.50	2.60	1.60	.80	1.40	1.80	2.25
4	2.35	2.20	3.10	2.25	3.30	3.65	2.60	1.45	.80	1.40	1.80	2.25
5	2.40	2.25	3.10	2.30	3.35	3.80	2.90	1.50	.80	1.30	1.70	2.10
6	2.50	2.35	3.10	2.40	3.50	3.85	2.80	1.80	.80	1.30	1.70	2.30
7	2.60	2.35	2.80	2.50	3.50	3.85	2.80	2.30	.80	1.30	1.75	2.35
8	2.70	2.25	2.80	2.60	3.40	3.90	2.65	1.95	.80	1.30	1.80	2.30
9	2.80	2.20	2.80	2.50	3.25	3.80	2.45	1.95	.80	1.30	1.80	2.30
10	2.80	2.30	2.80	2.50	3.20	3.75	2.20	1.65	.95	1.30	1.70	2.20
11	2.80	2.40	2.75	2.55	3.20	3.70	2.15	1.60	.90	1.30	1.75	2.25
12	2.90	2.40	2.50	2.60	3.20	3.60	2.10	1.60	.90	1.40	1.85	2.30
13	2.90	2.30	2.30	2.65	3.25	3.50	2.20	1.50	.90	1.40	1.80	2.30
14	2.90	2.30	2.15	2.60	3.30	3.50	2.10	1.45	.80	1.40	1.85	2.30
15	2.95	2.60	2.00	2.70	3.30	3.55	2.10	1.30	.80	1.40	1.90	2.20
16	3.00	2.40	2.40	2.90	3.30	3.60	2.15	1.30	.90	1.40	1.85	2.20
17	3.00	2.30	2.80	2.90	3.30	3.60	2.10	1.25	.90	1.50	1.80	2.20
18	3.00	2.35	2.30	2.90	3.45	3.60	2.05	1.15	.95	1.50	1.75	2.20
19	2.85	2.40	2.10	2.80	3.60	3.45	1.90	1.10	.95	1.50	1.60	2.20
20	2.85	2.50	2.00	2.70	3.60	3.30	2.00	.95	.95	1.50	1.70	2.30
21	2.75	2.50	2.40	2.65	3.50	3.30	2.00	1.45	.90	1.50	1.95	2.30
22	2.60	2.65	2.50	2.70	3.50	3.20	2.00	1.50	.90	1.50	1.95	2.40
23	2.65	2.70	2.40	2.80	3.45	3.10	2.10	1.35	.90	1.50	2.00	2.00
24	2.70	2.80	2.50	2.90	3.40	3.10	2.35	1.50	.90	1.60	1.95	2.00
25	2.50	2.80	2.45	3.00	3.40	3.10	2.35	1.45	.90	1.70	2.20	2.40
26	2.55	2.70	2.40	3.10	3.35	3.00	2.50	1.40	.90	1.60	2.25	2.45
27	2.00	2.60	2.40	3.10	3.30	2.90	2.35	1.20	1.00	1.60	2.30	1.85
28	1.70	2.60	2.30	3.05	3.25	2.90	2.00	1.20	1.10	1.60	2.15	1.80
29	1.90	.....	2.30	2.90	3.20	2.80	2.00	1.00	1.10	1.65	2.00	1.60
30	2.00	.....	2.25	2.95	3.20	2.80	2.00	1.00	1.25	1.70	2.00	.....
31	2.00	.....	2.30	.....	3.40	.....	1.90	.90	.....	1.75	.....	.....

SOUTH PLATTE RIVER.

The South Platte rises in the high mountain peaks surrounding the basin known as South Park, near the center of the State of Colorado. These mountains vary in altitude from 14,000 feet, in the Park Range, to 9,000 feet, in South Park. From the point where the stream issues from the mountains at Platte Canyon it flows in a northerly direction through Denver to its junction with the Cache la Poudre near Greeley, thence in a northeasterly direction until it leaves the State a short distance to the northeast of Julesburg, and thence in an easterly direction to its junction with the North Platte near North Platte, Nebraska.

The tributaries may be divided into two classes: (1) Those which, like the headwaters of the South Platte, rise in the mountains, and (2) those which drain the plains east of the mountains. The principal tributaries of the first class, in their order down the river, are Bear Creek, Clear Creek, St. Vrain Creek, Boulder and South Boulder creeks, Big Thompson Creek, and Cache la Poudre River. Among those of the second class there may be named, as especially worthy of consideration, Cherry Creek, Lone Tree Creek, Boxelder Creek, Bijou Creek, Beaver Creek, and Pawnee Creek. There are many others of lesser note. The streams of the first class—those flowing from the mountains—resemble the upper reaches of the South Platte in that they furnish a perennial supply of water, which varies, however, with the season, the discharge being great during the flood stages and low

during the latter part of the summer and in the fall and winter. The streams from the plains, on the other hand, are intermittent in their nature, usually furnishing water only during storms or the melting of snows. In general it may be said that the normal perennial discharge of all of the streams of this division is claimed and used for irrigation, but great quantities of water go to waste during the flood stages and in times of storms. As there is a vast amount of land upon the plains adjacent to the South Platte that might be irrigated if there were a sufficient supply of water, the question of storage becomes one of great importance, and the Geological Survey is now studying this problem, examining such reservoir sites as are considered capable of storing considerable quantities of water. It is hoped that reservoirs will be constructed to prevent the loss of this great amount of water, which, if properly stored, would become one of the greatest assets of the arid region.

An interesting feature of the South Platte Basin is the fact that in all of its valleys there is a great return from seepage, which is increasing from year to year, as may be seen in the tables of seepage measurements of this river published by the State engineer of Colorado. The underground water supply of the plains in this basin is also being studied, and the results of the investigations will be of great interest in determining the possibilities of procuring water from artesian sources for stock purposes and possibly for the irrigation of small tracts of land. The surface flow of the intermittent streams of the plains may be made available for irrigation purposes by the construction of suitable reservoirs, a few of which are now being utilized by corporations and private parties. The most notable projects of this character which have been under way in the basin during the year are the Lake Cheesman dam, which is being constructed by the Denver Union Water Company, C. L. Harrison, chief engineer, and the Bijou Irrigation Company's reservoirs in the neighborhood of Orchard. The Lake Cheesman reservoir is especially noteworthy on account of the great height of its dam (215 feet) and the amount of water to be stored. The dam will be of solid masonry. The reservoir sites of the Bijou Irrigation Company are natural basins, along the rims of which embankments will be constructed, thus storing large quantities of water, which will be conducted from the river through canals. Any great extension of the irrigated area of this district must depend upon the construction of additional reservoirs and upon improvements in the use and distribution of water. The present system of distribution throughout this section, as in nearly all of the arid region, is very extravagant, in many cases there being several times the number of ditch lines that the most economical use would demand, while much water goes to waste in marshes and swamps which might be drained, and an increased supply thus be made available.

SOUTH FORK OF SOUTH PLATTE RIVER AT LAKE CHEESMAN, COLORADO.

During the year 1900 the engineers in charge of the construction of the dam at Lake Cheesman kept practically continuous records of the gage heights and discharge of Goose Creek and South Platte River above their junction, and also of the combined discharge below the junction, the latter measurements being made below the dam. The accompanying table of discharge measurements at the latter place was obtained through the courtesy of Mr. C. L. Harrison, at present chief engineer of the Denver Union Water Company. The discharge for February is estimated, but it may be considered approximately correct. Discharges for the other months are from actual measurements, which are usually made three times a day, but sometimes oftener. The results may be considered very nearly correct.

SOUTH PLATTE RIVER NEAR PLATTE CANYON, COLORADO.

This station was located about 2 miles above the Colorado and Southern Railroad station at Platte Canyon. It was maintained by the Denver Union Water Company for some time previous to any cooperation on the part of the Survey, which began April 1, 1899. The gage rod was a 2-inch by 2-inch inclined timber on the right-hand side of the stream, the graduations being marked with brass nails. Measurements of discharge were made from the footbridge constructed by the water company at the rod. Readings were taken until June 2, 1900, inclusive, when extremely high water carried away the gage rod, which has not yet been replaced. Only two measurements were made in 1900. The channel at this point is rocky, but the high water changed it materially, so that it will be best for a new location to be selected. A station at this place is of great importance, and one should be maintained with care. A cable should be stretched across the river, with a traveling car, at such a height as to preclude the danger of its being washed away by floods. The figures given in the table show the actual discharge of the river at Platte Canyon before any water is diverted for irrigation or other purpose, except that taken out by the Denver Union Water Company a short distance above the station, for the supply of the city of Denver.

Readings were taken by James Proctor, of Littleton, Colorado, who is in charge of the pumping station of the Denver Union Water Company at that place. While the station was being maintained gage readings were furnished to the officers of the United States Weather Bureau at Denver, who had them published in the papers.

A description of the station was published in Water-Supply Paper No. 37, page 224. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 201. During 1900 the following measurements were made by A. L. Fellows:

March 5: Gage height, −0.40 foot; discharge, 87 second-feet.
April 18: Gage height, 1.55 feet; discharge, 467 second-feet.

Daily gage height, in feet, of South Platte River near Platte Canyon, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	0.3	−0.6	−0.5	0.2	4.7	5.6	17	−0.5	−0.8	0.5	1.4	5.3	.....
2	.2	− .6	− .4	.2	4.6	5.6	18	− .5	− .8	.5	1.6	5.4	.....
3	.1	− .7	− .3	.2	5.1	(a)	19	− .4	− .8	.5	1.9	5.4	.....
4	.1	− .7	− .3	.3	(b)	.....	20	− .4	− .8	.4	2.6	4.5	.....
5	.1	− .7	− .3	.4	(b)	.....	21	− .4	− .7	.3	3.3	4.5	.....
6	.1	− .7	− .5	.6	(b)	.....	22	− .4	− .7	.3	3.7	4.8	.....
7	.0	− .7	− .4	.6	(b)	.....	23	− .3	− .6	.3	3.8	4.8	.....
8	.0	− .7	− .2	.8	(b)	.....	24	− .3	− .7	.4	3.8	4.6	.....
9	−.2	− .7	− .1	.8	(b)	.....	25	− .4	− .7	.4	3.9	4.6	.....
10	−.4	− .7	− .2	.9	(b)	.....	26	− .5	− .7	.4	3.8	4.8	.....
11	−.3	− .8	− .1	.7	(b)	.....	27	− .4	− .7	.4	3.8	4.9	.....
12	−.5	− .8	+ .2	.8	(b)	.....	28	− .4	− .7	.3	4.2	5.2	.....
13	−.4	− .9	.4	1.0	(b)	.....	29	− .3	.....	.3	5.1	5.3	.....
14	−.4	− .9	.6	1.1	(b)	.....	30	− .4	.....	.3	4.8	5.4	.....
15	−.4	− .9	.5	1.6	(b)	.....	31	− .6	.....	.2	.....	5.5	.....
16	−.5	− .9	.6	1.6	5.3	.....							

a Gage washed away. b Gage out.

SOUTH PLATTE RIVER AT DENVER, COLORADO.

This station is located at the Fifteenth street bridge in the city of Denver, a short distance below the mouth of Cherry Creek. It was established July 15, 1895, and has been maintained continuously. For a portion of the last year two rods were in use, one on the left bank and the other on the right bank a short distance below the bridge. Both were inclined rods. The rod on the left bank was washed out by the high water of June, 1900, which also removed the sand bar in front of the rod on the right-hand side, making it available at low-water stages, which it had not been before, and since that time the readings have been taken from the latter rod. The bench mark is a cross on the north corner of the top of the east abutment of the Fifteenth street bridge, and is 15.15 feet above gage datum. The river at this point is confined between slag embankments, but owing to the shifting sandy bottom the channel is very changeable, rendering necessary frequent changes in the rating tables. The observations have been made by the water commissioners of water district No. 2, in which Denver is located, W. J. Southland and his successor, S. M. Matlock. During 1900 eleven gagings were made at this point. The daily gage height, with corresponding discharge, was published in the Denver papers by the United States Weather Bureau. A description of the station was published in Water-Supply Paper No. 37, page 225. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 202. During 1900 the following measurements were made by A. L. Fellows and R. W. Hawley:

Discharge measurements of South Platte River at Denver, Colorado.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
March 6	5.50	244	July 25	5.45	257
April 12	5.90	377	August 7	5.56	285
April 16	7.24	1,439	August 29	4.90	90
April 20	7.10	1,395	October 20	5.50	236
April 23	8.32	3,516	October 22	5.30	161
June 11	8.50	3,270			

Daily gage height, in feet, of South Platte River at Denver, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.30	5.35	5.25	5.05	9.40	8.75	6.65	5.00	4.75	4.90	5.00	5.00
2	5.35	5.45	5.35	5.00	9.40	8.92	6.55	5.10	a4.75	4.80	5.10	5.10
3	5.35	5.20	5.25	5.10	9.40	8.90	6.35	5.20	a4.75	4.80	5.10	5.20
4	5.30	5.25	5.30	5.05	9.40	9.00	6.35	5.40	4.75	4.90	5.40	5.20
5	5.25	5.25	5.45	5.30	9.35	8.90	6.30	5.45	4.85	4.90	5.30	5.20
6	5.35	5.35	5.45	5.50	9.35	8.80	6.30	5.50	4.70	4.85	5.30	5.30
7	5.35	5.40	5.25	5.60	9.35	8.60	6.30	5.50	4.85	4.70	5.20	5.20
8	5.40	5.30	5.20	5.50	9.40	8.50	6.30	5.55	5.05	4.80	5.30	5.30
9	5.35	5.25	5.20	6.00	9.45	8.50	6.20	5.45	4.90	4.90	5.30	5.30
10	5.45	5.25	5.20	5.95	9.40	8.55	6.20	5.45	4.85	4.90	5.30	5.10
11	5.60	5.20	5.30	6.60	9.50	8.55	6.10	5.50	4.95	4.90	5.30	5.20
12	5.40	5.25	5.20	6.45	9.50	8.50	5.70	5.35	5.60	4.90	5.30	5.20
13	5.30	5.25	5.40	6.20	9.40	8.45	5.55	5.35	5.60	4.90	5.20	5.30
14	5.35	5.30	5.40	6.30	9.00	8.40	5.45	5.10	5.35	4.90	5.20	5.30
15	5.45	5.30	5.40	6.65	8.75	8.15	5.40	5.15	5.00	4.90	5.10	5.30
16	5.40	5.40	5.25	7.35	8.50	8.00	5.40	5.05	5.05	5.20	5.10	5.20
17	5.35	5.35	5.30	7.60	8.40	7.95	5.50	4.90	5.20	5.10	5.10	5.20
18	5.45	5.40	5.35	6.80	8.48	7.70	5.35	4.95	5.15	5.00	5.20	5.20
19	5.35	5.45	5.25	6.75	8.30	7.60	5.10	4.80	5.25	5.00	5.20	5.30
20	5.30	5.50	5.40	7.70	8.40	7.58	5.15	4.95	5.10	5.00	5.20	5.30
21	5.40	5.45	5.30	7.75	8.60	7.35	5.00	4.90	5.10	5.20	5.30	5.40
22	5.30	5.35	5.25	7.95	8.50	7.25	5.00	5.00	5.10	5.20	5.40	5.40
23	5.40	5.25	5.25	8.40	8.50	7.45	5.15	4.95	4.90	5.20	5.40	5.30
24	5.35	5.25	5.20	8.40	8.35	7.55	5.15	5.05	4.85	5.10	5.50	5.30
25	5.45	5.30	5.30	8.40	8.40	7.55	5.85	5.20	5.00	5.00	5.50	5.20
26	5.35	5.35	5.25	8.40	8.30	7.50	5.60	5.10	5.20	5.10	5.50	5.20
27	5.25	5.40	5.35	8.05	8.45	7.45	5.55	5.00	5.20	5.10	5.40	5.30
28	5.35	5.30	5.40	8.10	8.50	7.25	5.60	4.95	5.20	4.90	5.40	5.40
29	5.35	.....	5.35	9.75	8.75	7.05	5.50	4.90	5.00	4.90	5.30	5.45
30	5.40	.....	5.10	9.50	8.70	6.70	5.30	4.80	4.90	4.90	5.20	5.50
31	5.30	.....	5.10	.....	8.75	.....	5.00	4.70	.....	4.90	.....	5.40

a Estimated.

SOUTH PLATTE RIVER AT ORCHARD, COLORADO.

This station is on the lower part of the South Platte, below all of the mountain drainage tributary to that stream. The gage rod, which is vertical, is fastened to a pile at a wagon bridge about a quarter of a mile southwest of the Union Pacific Railroad station at Orchard. The station was first established in November, 1895, and has been maintained during the greater part of the time since. During the last year the gage rod had to be moved twice, owing to changes in the channel. The left bank of the river is high, but the right bank is low and is likely to overflow. The bed of the stream is sandy and shifting, but the cross section did not change materially during 1900. The station has been of great value in demonstrating the fact that large quantities of water go to waste during floods and during the winter season, a great portion being seepage or return water. As a result of the investigations at this place, a large irrigation enterprise has been undertaken—namely, that of diverting water from the river near Hardin for the purpose of irrigating lands in the vicinity of Fort Morgan, the water to be stored in large reservoirs, which are referred to elsewhere (page 279, Bijou Irrigation Company's reservoirs). The existence of a large flow having been demonstrated, it is now thought best that the station should be changed to a point farther upstream, probably at Kersey, where another large ditch might possibly be taken out. A description of the station was published in Water-Supply Paper No. 37, page 226. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 203. During

1900 the following measurements were made by A. L. Fellows and R. W. Hawley:

March 7: Gage height, 2.85; discharge, 668 second-feet.
April 21: Gage height, 5 feet; discharge, 4,674 second-feet.
July 23: Gage height, 1.35 feet; discharge, 156 second-feet.
October 27: Gage height, 2.70 feet; discharge, 324 second-feet.

Daily gage height, in feet, of South Platte River at Orchard, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	2.90	3.20	2.70	8.50	6.50	2.70	1.20	1.10	2.40	2.70	2.80
2	4.00	2.90	3.30	2.70	8.50	6.50	2.50	1.20	1.10	2.50	2.70	2.80
3	3.90	2.90	3.30	2.90	8.00	6.50	2.40	1.15	1.10	2.60	2.70	2.80
4	3.90	2.90	3.20	3.00	8.00	6.50	2.30	1.10	1.10	2.60	2.75	2.80
5	3.90	2.90	3.00	3.20	8.00	6.30	2.20	1.10	1.20	2.65	2.75	2.80
6	3.90	2.90	2.85	3.30	8.20	6.00	2.10	1.10	1.30	2.70	2.80	2.80
7	3.90	2.90	2.85	3.40	8.00	5.90	2.00	1.10	1.30	2.70	2.80	2.80
8	3.90	2.90	2.85	3.40	7.80	5.80	2.00	1.10	1.30	2.70	2.80	2.80
9	3.60	2.90	2.85	3.50	7.50	5.70	1.90	1.10	1.30	2.70	2.80	2.80
10	3.60	2.90	2.85	3.60	7.30	5.60	1.80	1.10	1.30	2.70	2.80	2.80
11	3.60	3.00	2.85	3.75	7.50	5.50	1.70	1.10	1.30	2.70	2.85	2.80
12	3.60	3.00	2.80	3.90	8.00	5.40	1.60	1.10	1.30	2.70	2.85	2.80
13	3.60	3.00	2.80	4.00	8.20	5.30	1.50	1.10	1.30	2.70	2.90	2.80
14	3.50	3.30	2.80	4.10	8.00	5.20	1.40	1.10	1.30	2.70	2.90	2.80
15	3.50	3.30	2.80	4.50	7.80	5.10	1.30	1.10	1.30	2.70	2.80	2.80
16	3.40	3.30	2.80	5.00	7.00	4.90	1.35	1.10	1.30	2.70	2.80	2.80
17	3.30	3.30	2.80	6.25	6.80	4.80	1.35	1.10	1.30	2.70	2.80	2.80
18	3.20	3.50	2.80	6.70	6.00	4.75	1.35	1.10	1.30	2.70	2.80	2.80
19	3.00	3.50	2.70	5.50	5.80	4.70	1.35	1.10	1.30	2.70	2.80	2.80
20	2.80	3.50	2.70	5.20	6.00	4.60	1.35	1.10	1.30	2.70	2.80	2.80
21	2.80	3.50	2.70	5.00	7.00	4.50	1.35	1.10	1.30	2.70	2.80	2.80
22	2.90	3.40	2.70	5.30	6.00	4.30	1.35	1.10	1.30	2.70	2.80	2.80
23	2.90	3.40	2.70	6.50	6.00	4.20	1.35	1.10	1.40	2.70	2.80	2.80
24	2.90	3.40	2.70	6.40	6.00	4.00	1.30	1.10	1.50	2.70	2.80	2.80
25	2.90	3.30	2.70	6.30	6.00	3.90	1.30	1.10	1.65	2.70	2.80	2.80
26	2.90	3.20	2.70	6.10	6.00	3.80	1.30	1.10	1.80	2.70	2.80	2.80
27	2.90	3.20	2.70	6.00	6.30	3.70	1.30	1.10	1.95	2.70	2.80	2.80
28	2.90	3.20	2.70	6.00	6.50	3.50	1.30	1.10	2.10	2.70	2.80	2.80
29	2.90	.....	2.70	6.30	6.70	3.00	1.35	1.10	2.20	2.70	2.80	2.80
30	2.90	.....	2.70	7.30	6.80	2.80	1.40	1.10	2.30	2.70	2.80	2.80
31	2.90	.....	2.70	.....	6.70	.....	1.40	1.10	.....	2.70	.....	2.80

SOUTH PLATTE RIVER AT JULESBURG, COLORADO.

Although no station has yet been established at this place, one is greatly needed. A rod was attached to the wagon bridge about a mile southeast of the Union Pacific Railroad station at Julesburg, but no one was found who would make the observations, so that no record has been kept. A station here would be of great value, as the bridge referred to is not far from the State line, and a knowledge of the discharge passing from Colorado into Kansas could thus be obtained. The channel is very wide, as it is throughout the lower portion of the river, and on this account the results obtained would necessarily be approximate; but they would nevertheless be valuable. Within the last two years four measurements have been made at this place, as follows:

Discharge measurements of South Platte River at Julesburg, Colorado.

	Sec.-ft.
September 14, 1899	2
November 12, 1899	1,120
March 8, 1900	2,291
November 2, 1900	76

On December 20, 1900, the South Platte was measured at North Platte, Nebraska, by Adna Dobson, and a discharge of 963 second-feet was found.

BEAR CREEK NEAR MORRISON, COLORADO.

Bear Creek is one of the smaller tributaries of the South Platte, heading in the vicinity of Mount Evans, about 30 miles southwest of Denver, and entering the main stream about 8 miles above that city. Although usually of small volume, the stream drains a considerable portion of very mountainous country, which is subject to more or less violent cloudbursts, so that floods sometimes come down this creek, causing great destruction to property and even the loss of life. All of the normal flow of the stream is used for irrigation, and it is only during high-water stages that a large amount of water passes through it. Records of its flow have been kept for a portion of each irrigation season since April, 1888, with the exception of the years 1892, 1893, and 1894. The present station was established April 16, 1899. It is located just above the little town of Morrison. The gage rod, which is a 2-inch by 4-inch timber placed vertically and marked in feet and tenths, is fastened to the upper side of the dam which diverts water into the mains of the Denver Union Water Company. The bench mark is the top of a granite bowlder about 100 feet above the rod on the left-hand side of the stream, and it is 10.33 feet above the gage datum. As in previous years, the station was maintained through cooperation with the Denver Union Water Company. Owing to the formation of a gravel bar in the summer of 1900, the conditions were for some time radically changed from the normal, and during the month of September no gagings were taken. The observer is S. Hebrew, an employee of the Denver Union Water Company. Tables of gage heights and discharge measurements for 1899 will be found in Water-Supply Paper No. 37, pages 227 and 228. Table of the monthly flow for that year will be found in the Twenty-first Annual Report, Part IV, page 204. During 1900 the following measurements were made by A. L. Fellows:

March 9: Gage height, 1.40 feet; discharge, 17 second-feet.
April 14: Gage height, 2.85 feet; discharge, 47 second-feet.
April 25: Gage height, 5.80 feet; discharge, 367 second-feet.
August 7: Gage height, 3.20 feet; discharge, 63 second-feet.
September 6: No gage height taken (conditions abnormal); discharge, 24 second-feet.

Daily gage height, in feet, of Bear Creek near Morrison, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.70	5.95	4.75	3.55	2.00	2.60	1.90	1.35
2	.....	6.25	6.25	4.65	3.45	(a)	2.55	1.85	1.35
3	.....	6.30	6.55	4.55	3.30	.....	2.45	1.80	1.45
4	.....	6.20	6.60	4.55	4.00	.....	2.40	1.80	1.55
5	.....	6.20	6.40	4.35	4.00	.....	2.35	1.70	.....
6	.....	6.30	6.10	4.30	3.75	.....	2.30	1.70	.....
7	.....	6.40	6.25	4.35	3.70	.....	2.25	1.70	.....
8	.....	6.50	6.25	4.30	3.60	.....	2.30	1.60	.....
9	.....	6.50	6.15	4.25	3.50	.....	2.20	1.60	.....
10	.....	6.70	6.50	4.20	3.40	.....	2.20	1.60	.....
11	.....	6.90	6.40	4.15	3.30	.....	2.20	1.60	.....
12	.....	6.75	6.10	4.10	3.05	.....	2.10	1.60	.....
13	.....	6.65	5.95	4.10	2.85	.....	2.10	1.50	.....
14	3.00	6.45	5.95	4.05	2.65	.....	2.10	1.50	.....
15	2.90	6.20	5.85	4.00	2.45	.....	2.00	1.50	.....
16	2.95	6.05	5.85	4.20	2.35	.....	2.00	1.40	.....
17	3.65	5.90	5.70	4.10	2.25	.....	2.00	1.40	.....
18	3.65	5.90	5.70	4.05	2.20	.....	2.00	1.30	.....
19	4.50	5.90	5.60	4.00	2.10	.....	2.00	1.30	.....
20	4.80	6.05	5.60	3.90	2.20	.....	1.90	1.20	.....
21	5.30	5.95	5.55	3.80	2.25	.....	1.90	1.20	.....
22	5.80	5.95	5.55	3.75	2.30	.....	1.90	1.20	.....
23	5.85	6.05	5.50	4.00	2.30	.....	1.85	1.10	.....
24	5.80	6.05	5.40	4.35	2.20	.....	1.80	1.10	.....
25	5.90	6.15	5.25	4.40	2.10	.....	1.80	1.20	.....
26	6.15	6.20	5.25	4.25	2.10	.....	1.70	1.35	.....
27	6.25	6.20	5.15	4.15	2.10	.....	1.70	1.40	.....
28	6.30	6.10	5.15	4.05	2.10	.....	1.70	1.50	.....
29	7.00	6.10	5.05	4.00	2.05	.....	1.80	1.45	.....
30	6.90	6.05	4.95	3.85	2.00	2.70	2.00	1.40	.....
31	.....	6.00	.....	3.75	2.00	.....	2.00	.....	.....

a Gage heights not taken from September 2 to 29, inclusive, on account of dam on stream raising the water.

CLEAR CREEK AT FORKSCREEK, COLORADO.

Clear Creek rises on the eastern slope of the Rocky Mountains, in the vicinity of Grays and James peaks, about 40 miles west of Denver, and flows easterly, entering the South Platte 6 miles below the center of that city. Like the other streams of this region, for a long distance it flows through mountainous country, the water being used for power purposes and for placer mining. At Golden the creek enters an open and fertile valley, and so large a proportion of the water is diverted, by means of irrigation canals, for the cultivation of the land lying along the stream, that little of the normal flow passes into the South Platte, except that returned by seepage. During the flood stages, however, considerable water enters the main stream. The gaging station is located at the Forkscreek railroad station on the Colorado and Southern Railway, in Clear Creek Canyon, just below the junction of the North and South forks of Clear Creek. It was established May 29, 1899, and has been continued through the irrigation seasons of 1899 and 1900. The gage consists of a weight fastened to a wire running over a pulley at the edge of the embankment upon which the railway station is located. It is referred to bench marks back of the embankment. The stream flows rapidly through this part of the canyon, the channel being rocky and the fall great. Both banks are high and rocky. There is no suitable means for crossing the river at the gaging station, the railway bridge over the stream being con-

structed at an acute angle. It is possible, however, to secure fairly good results by means of measurements made at the two bridges above the forks, thus securing data of the flow of each branch as well as the total flow. At low water the stream may be gaged by wading. During the last two years the observer has been C. N. Davis, railway station agent at Forkscreek. He has voluntarily made the readings and sent daily reports to the local forecast official in Denver, who has had them published in the morning papers. A description of the station was published in Water-Supply Paper No. 37, page 228. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 205. During 1900 the following measurements were made by A. L. Fellows:

March 10: Gage height, 1.60 feet; discharge, 55 second-feet.
April 13: Gage height, 1.70 feet; discharge, 73 second-feet.
April 24: Gage height, 2.60 feet; discharge, 290 second-feet.
August 27: Gage height, 1.78 feet; discharge, 130 second-feet.

Daily gage height, in feet, of Clear Creek at Forkscreek, Colorado, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.60	2.80	4.40	3.60	2.40	1.70	1.60	1.60	1.55
2	.....	1.60	2.80	4.35	3.50	2.35	1.70	1.60	1.60	1.55
3	.....	1.60	2.80	4.05	3.25	2.25	1.70	1.60	1.60	1.55
4	.....	2.10	2.85	4.20	3.25	2.25	1.70	1.60	1.55	1.55
5	.....	2.10	3.00	4.10	3.20	2.30	1.70	1.60	1.55	.....
6	.....	2.15	3.25	4.20	3.20	2.25	1.65	1.60	1.55	.....
7	.....	2.05	3.30	4.35	3.20	2.20	1.60	1.60	1.55	.....
8	.....	1.85	3.40	4.55	3.10	2.15	1.60	1.60	1.55	.....
9	.....	1.80	3.55	4.55	3.10	2.10	1.60	1.60	1.55	.....
10	1.65	1.85	3.90	4.45	3.00	2.10	1.70	1.60	1.55	.....
11	1.70	1.80	4.30	4.05	3.00	2.10	1.65	1.60	1.55	.....
12	1.65	1.80	4.55	3.95	2.85	2.10	1.60	1.60	1.55	.....
13	1.70	1.75	4.20	4.00	2.80	2.00	1.60	1.60	1.55	.....
14	1.70	1.80	3.75	3.90	2.75	2.00	1.60	1.70	1.55	.....
15	1.55	1.80	3.15	3.90	2.75	2.00	1.60	1.65	1.55	.....
16	1.60	1.85	3.45	4.05	2.70	1.90	1.60	1.60	1.55	.....
17	1.65	1.85	3.80	4.05	2.70	1.90	1.55	1.60	1.55	.....
18	1.60	1.80	3.70	4.00	2.65	1.90	1.50	1.60	1.55	.....
19	1.50	2.00	3.70	4.00	2.55	1.90	1.50	1.60	1.55	.....
20	1.60	2.35	3.75	4.00	2.50	1.90	1.50	1.60	1.55	.....
21	1.60	2.35	3.75	4.00	2.50	1.90	1.50	1.60	1.55	.....
22	1.60	2.65	3.60	4.00	2.50	1.90	1.50	1.60	1.55	.....
23	1.60	2.60	3.75	4.00	2.50	1.90	1.50	1.60	1.55	.....
24	1.60	2.60	3.65	3.90	2.50	1.85	1.50	1.60	1.55	.....
25	1.60	2.70	4.05	3.85	2.50	1.80	1.60	1.60	1.55	.....
26	1.60	2.55	4.05	3.80	2.50	1.80	1.60	1.60	1.55	.....
27	1.60	2.55	4.10	3.60	2.50	1.80	1.60	1.60	1.55	.....
28	1.60	2.60	4.35	3.60	2.50	1.80	1.60	1.60	1.55	.....
29	1.60	2.90	4.40	3.60	2.50	1.80	1.60	1.55	1.55	.....
30	1.60	2.90	4.45	3.70	2.40	1.80	1.60	1.55	1.55	.....
31	1.60	.....	4.30	.....	2.40	1.75	.....	1.60	.....	.....

SOUTH BOULDER CREEK NEAR MARSHALL, COLORADO.

South Boulder Creek, a tributary of Boulder Creek, is the next mountain stream of importance north of Clear Creek. The gaging station, which was established in April, 1888, and has been maintained during a portion of each year since, except during 1893 and 1894, is located at the mouth of the canyon from which the stream issues about 3 miles west of the Colorado and Southern Railway station at Marshall. The rod consists of an inclined timber on the

north bank of the stream near the house of C. E. Barber. Above the station two ditches divert water, namely, the South Boulder and Coal Creek ditch and the Community ditch, and their discharges must be added to the discharge at the station, in order to obtain the total run-off of the basin. The channel of the stream, which is rocky and full of bowlders, does not change materially. Gagings are usually made by wading, but at high water they are made from the footbridge just above the rod. The observer during 1900 was Miss Blanche Barber, who lives near by. A description of the station was published in Water-Supply Paper No. 37, page 229. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 206. During 1900 the following measurements were made by A. L. Fellows:

July 28: Gage height, 1.40 feet; discharge, 35 second-feet.
August 28: Gage height, 1.10 feet; discharge, 10 second-feet.

Daily gage height, in feet, of South Boulder Creek near Marshall, Colorado, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	3.45	2.40	1.45	1.00	17	.....	2.55	1.80	1.30	1.05
2	.....	3.45	2.30	1.50	1.05	18	.....	2.65	1.75	1.30	1.10
3	.....	3.45	2.30	1.50	1.00	19	.....	2.70	1.70	1.30	1.05
4	.....	3.40	2.20	1.50	1.05	20	.....	2.65	1.70	1.25	1.00
5	.....	3.20	2.25	1.60	1.05	21	.....	2.85	1.70	1.30	1.05
6	4.00	3.20	2.15	1.50	1.05	22	.....	2.75	1.70	1.25	1.15
7	4.00	3.20	2.15	1.50	1.05	23	.....	2.70	1.70	1.30	1.15
8	4.00	3.20	2.10	1.45	1.05	24	.....	2.65	1.60	1.35	1.10
9	4.00	3.05	2.05	1.40	1.00	25	.....	2.60	1.55	1.35	1.15
10	4.00	3.00	1.80	1.40	1.20	26	.....	2.45	1.55	1.30	1.20
11	4.00	2.95	1.80	1.40	1.10	27	.....	2.50	1.60	1.20	1.10
12	4.00	2.90	1.80	1.30	1.10	28	.....	2.45	1.40	1.20	1.10
13	(a)	2.90	1.80	1.40	1.10	29	.....	2.45	1.40	1.10	1.10
14	.....	2.90	1.80	1.35	1.00	30	.....	2.40	1.70	1.10	1.00
15	.....	2.60	1.85	1.35	1.05	31	.....	.....	1.60	1.00	.....
16	.....	2.70	1.80	1.30	1.00						

a Regular readings did not begin until June 1.

BOULDER CREEK NEAR BOULDER, COLORADO.

The general character of Boulder Creek, one of the tributaries of St. Vrain Creek, is similar to that of the latter stream. The gaging station is located 1½ miles above the town of Boulder, where the stream issues from the mountains. There are two small irrigation ditches above the station, but the amount of water diverted does not exceed 5 or 6 second-feet, and may, therefore, be disregarded. The channel of the stream contains so many large bowlders that accurate measurements are difficult to obtain, either here or at any other point. During high water measurements are made from the bridge, but at low-water stages the stream can be gaged by wading. The entire normal flow is used for irrigation, but large quantities of water go to waste during the flood season. Plans are being considered for the construction of large reservoirs to store the flood waters for the irrigation of lands now arid. The gage rod is an inclined timber spiked to stakes driven

into the bank. The bench mark is the top of a large stone 22 feet west of the gage and 5.72 feet above the zero of the rod. Both banks are high and rocky, and are not subject to overflow. The observer for 1900 was Mrs. Carrie Osgood, who lives near by. A description of the station was published in Water-Supply Paper No. 37, page 231. The results of measurements for 1897, 1898, and 1899 will be found in the Twenty-first Annual Report, Part IV, page 207. During 1900 the following measurements were made by A. L. Fellows:

April 28: Gage height, 2.10 feet; discharge, 483 second-feet.
July 27: Gage height, 1.40 feet; discharge, 220 second-feet.
August 28: Gage height, 0.62 foot; discharge, 49 second-feet.

Daily gage height, in feet, of Boulder Creek near Boulder, Colorado, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	2.35	2.85	2.00	1.22	0.60	0.45	17	2.25	2.42	1.40	0.75	0.55	0.62
2	2.35	2.75	1.95	1.22	.60	.45	18	2.20	2.42	1.40	.78	.55	.60
3	2.30	2.75	1.95	1.22	.62	.42	19	2.15	2.35	1.38	.72	.55	.60
4	2.40	2.65	1.82	1.20	.62	.45	20	2.22	2.40	1.40	.73	.50	.58
5	2.62	2.68	1.70	1.18	.60	.42	21	2.20	2.35	1.32	.70	.50	.55
6	2.52	2.72	1.60	1.18	.60	.48	22	2.22	2.38	1.35	.68	.50	.52
7	2.55	2.68	1.50	1.12	.60	.50	23	2.20	2.40	1.38	.65	.48	.45
8	2.70	2.78	1.45	1.08	.62	.48	24	2.18	2.35	1.35	.75	.45	.43
9	2.68	2.75	1.40	.98	1.17	.50	25	2.18	2.30	1.32	.73	.50	.40
10	2.70	2.78	1.40	.98	.95	.48	26	2.25	2.25	1.38	.72	.65	.37
11	2.65	2.60	1.50	.98	.90	.50	27	2.52	2.22	1.38	.68	.65	.33
12	2.75	2.58	1.62	.92	.88	.67	28	2.70	2.20	1.38	.60	.55	.30
13	2.62	2.45	1.52	.90	.82	.75	29	2.75	2.10	1.25	.60	.52	.32
14	2.48	2.40	1.52	.85	.80	.60	30	2.70	2.08	1.22	.62	.55	.35
15	2.35	2.40	1.60	.80	.65	.55	31	2.78	.....	1.22	.60	.....	.25
16	2.30	2.42	1.55	.78	.60	.70							

ST. VRAIN CREEK NEAR LYONS, COLORADO.

St. Vrain Creek and its tributaries derive their supply of water from the eastern slope of the Front Range, between Longs Peak and James Peak, which are about 30 miles apart. The general trend of the drainage is northeasterly, the St. Vrain flowing into South Platte River about 6 miles below the town of Platteville. The principal tributaries of the stream are the North and South forks and Boulder Creek. South Boulder Creek is a tributary of the latter stream. In their upper portions these creeks flow through mountainous areas where the water is used only for power purposes and for placer mining, but at the foothills each stream emerges into a broad, approximately level valley, devoted entirely to farming, water being furnished by means of irrigation canals leading from the streams. Three stations are maintained on the main stream and its tributaries, namely, at Lyons, on the St. Vrain, at Boulder, on the Boulder, and at Marshall, on the South Boulder. The station at Lyons is about a half mile southeast of the town, and is below the intersection of the North and South forks.

Records of the flow of the creek at or near Lyons have been kept since April, 1888, except during the years 1893 and 1894, but the station was not put in its present condition until May 5, 1899, since when

records have been kept throughout each irrigation season. The rod is an inclined timber on the left bank of the stream, opposite the Tower Hotel, fastened to pieces of timber driven into the slag embankment. The stream has an excellent channel of gravel and bowlders, and is not likely to change. Measurements have usually been made by wading, but at high water they are made from the bridge about a quarter of a mile below the gage rod. The bench mark is a spike 2 feet from the west side of the trunk of a large cottonwood tree 150 feet north of the rod. Supply ditch diverts water above the station, and its discharge should be added to that of the creek in order to obtain the total run-off of the basin. The observer during the year 1900 was L. H. Dickson, commissioner of the St. Vrain water district, who kept up the readings during the irrigation season. Weekly records of the discharge at this point have been furnished to the Longmont papers. During the greater part of the irrigation season the entire discharge of St. Vrain Creek is utilized, but during the flood period considerable water usually goes to waste. Much of the water is, however, stored in reservoirs, and is used to advantage at low stages of the stream. A description of the station was published in Water-Supply Paper No. 37, page 232. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 208. During 1900 the following measurements were made by A. L. Fellows:

March 13: Gage height, 2.06 feet; discharge, 35 second-feet.
April 27: Gage height, 3.68 feet; discharge, 513 second-feet.
July 27: Gage height, 2.70 feet; discharge, 193 second-feet.

Daily gage height, in feet, of St. Vrain Creek near Lyons, Colorado, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1			4.10	4.50	3.50	2.55	2.15	2.10	2.05
2			4.00	4.30	3.45	2.55	2.15	2.10	2.05
3			3.90	4.50	3.35	2.50	2.15	2.10	2.05
4			4.00	4.40	3.25	2.50	2.15	2.08	2.05
5			4.15	4.20	3.10	2.50	2.15	2.08	2.05
6			4.10	4.10	3.10	2.55	2.15	2.08	2.05
7			4.15	4.30	3.10	2.50	2.15	2.10	2.05
8		3.20	4.10	4.35	3.10	2.47	2.23	2.10	2.05
9	1.90		4.30	4.40	3.00	2.47	2.23	2.10	2.05
10	1.90		4.15	4.30	2.95	2.45	2.23	2.10	2.05
11			4.15	3.90	3.05	2.45	2.75	2.08	2.00
12			4.10	3.85	3.05	2.40	2.70	2.05	2.00
13	2.06		4.10	3.80	3.05	2.35	2.45	2.05	
14			3.95	3.95	3.05	2.30	2.35	2.05	
15		2.06	3.75	3.80	3.05	2.30	2.25	2.05	
16		1.90	3.65	3.85	3.05	2.30	2.20	2.30	
17	1.85	1.85	3.70	3.85	3.00	2.30	2.15	2.25	
18		1.90	3.70	3.90	2.90	2.25	2.15	2.20	
19		1.85	3.65	3.95	2.90	2.25	2.12	2.20	
20		1.90	3.50	4.00	2.80	2.25	2.12	2.25	
21		1.90	3.60	4.00	2.75	2.25	2.12	2.20	
22	1.90	4.20	3.80	3.95	2.70	2.25	2.10	2.18	
23		3.80	3.70	4.00	2.70	2.25	2.10	2.15	
24		3.90	3.95	3.90	2.80	2.23	2.08	2.15	
25		3.80	3.60	3.80	2.75	2.23	2.10	2.15	
26		3.80	4.00	3.65	2.70	2.20	2.18	2.15	
27		3.70	4.20	3.55	2.70	2.17	2.15	2.15	
28		3.75	4.60	3.55	2.70	2.15	2.18	2.10	
29		4.80	4.60	3.50	2.70	2.15	2.10	2.10	
30	1.95	4.30	4.70	3.45	2.65	2.15	2.10	2.10	
31			4.50		2.65	2.15		2.05	

NOTE.—Regular readings did not begin until April 15.

BIG THOMPSON CREEK NEAR ARKINS, COLORADO.

This stream drains the country immediately north of that drained by the headwaters of St. Vrain Creek, and is one of the largest tributaries of South Platte River, into which it empties about 4 miles above the town of Evans. Little Thompson Creek is an important tributary of Big Thompson Creek, and the country drained by these two streams makes up irrigation district No. 4. The junction of these creeks is near the lower end of the district, a short distance above the point where their combined waters enter the South Platte.

Records of the flow of this stream were begun in April, 1888, and have been maintained for a portion of each year since, with the exception of the years 1893 and 1894. The station was established at its present location on April 1, 1899. The only diversion above the gaging station is Handy ditch, a record of the gage heights of which is kept by the water commissioner of that district, J. M. Wolaver, who has also kept the records of Big Thompson Creek at this point during the year 1900. It is necessary to include the discharge of Handy ditch in order to obtain the total run-off of the basin. The rod is a vertical 2-inch by 4-inch timber fastened to the downstream side of the right-hand end of the wagon bridge on the ranch of John Chasteen. The bench mark is 25 feet south of the gage, and is a nail in the root of a cottonwood stump, the head of the nail being 9.35 feet above the zero of gage. The channel of the stream is lined with bowlders and is very rough, but, not being likely to change, it furnishes a good point for obtaining accurate measurements. A permanent station could be located here to advantage. Like the other tributaries of the South Platte, nearly all of the normal flow of Big Thompson and Little Thompson creeks is used for irrigation, and during the high-water stages the greater part of the volume is diverted into large reservoirs, from which it is used to advantage later in the season. A description of the station was published in Water-Supply Paper No. 37, page 233. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 209. During 1900 the following measurements were made by A. L. Fellows:

April 26: Gage height, 1.91 feet; discharge, 512 second-feet.
July 26: Gage height, 1.35 feet; discharge, 322 second-feet.

Daily gage height, in feet, of Big Thompson Creek near Arkins, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.20	3.50	3.50	2.00	1.10	0.70	17	1.60	2.70	2.90	1.50	0.80	0.60
2	.20	3.40	3.60	1.80	1.10	.70	18	1.60	2.80	2.80	1.40	.80	.60
3	.30	3.40	3.40	1.80	1.10	.70	19	2.00	2.80	2.80	1.40	.80	.60
4	.50	3.30	3.20	1.70	1.10	.70	20	2.00	2.50	2.80	1.40	.80	.60
5	.60	2.80	2.90	1.70	1.10	.70	21	2.20	2.60	2.80	1.20	.80	.60
6	.60	2.60	3.00	1.70	1.10	.70	22	1.90	2.65	2.80	1.20	.80	.60
7	.70	2.60	3.40	1.70	1.10	.70	23	1.80	2.75	2.90	1.20	.80	.60
8	.90	2.70	3.40	1.80	1.10	.70	24	1.80	2.75	2.80	1.30	.70	.60
9	.90	2.80	3.50	1.80	1.00	.70	25	1.80	2.80	2.80	1.30	.70	.60
10	.90	3.10	3.10	1.70	1.00	.70	26	1.90	3.10	2.70	1.20	.70	.60
11	1.00	3.10	3.00	1.70	.90	.70	27	1.90	3.30	2.60	1.20	.70	.60
12	1.00	3.00	2.90	1.60	.80	.70	28	2.10	3.50	2.50	1.30	.70	.70
13	1.10	2.90	3.00	1.60	.80	.70	29	3.00	3.60	2.40	1.30	.70	.70
14	1.10	2.90	3.00	1.60	.80	.70	30	3.50	3.70	2.30	1.20	.70	.70
15	1.90	2.90	3.00	1.60	.80	.70	31	.....	3.50	.....	1.10	.70	.....
16	1.80	2.70	3.00	1.70	.80	.60							

Daily gage height, in feet, of Handy ditch near Arkins, Colorado, for 1900.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	.....	1.20	0.40	0.32	12	.....	0.72	0.32	0.30	23	2.20	0.40	0.32	.30
2	.....	1.20	.40	.30	13	.....	.72	.32	.30	24	2.20	.40	.32	.30
3	.....	1.20	.40	.30	14	.....	.72	.32	.30	25	2.20	.40	.32	.30
4	.....	1.20	.40	.30	15	.....	.72	.32	.30	26	2.20	.40	.32	.30
5	.....	.80	.40	.30	16	.....	.72	.32	.30	27	2.20	.40	.32	.30
6	.....	.80	.40	.30	17	2.20	.72	.32	.30	28	1.20	.40	.32	.30
7	.....	.80	.40	.30	18	2.20	.72	.32	.30	29	1.20	.40	.32	.30
8	.....	.72	.45	.30	19	2.20	.72	.32	.30	30	1.20	.40	.32	.....
9	.....	.72	.45	.30	20	2.20	.72	.32	.30	31	.....	.40	.32	.....
10	.....	.72	.40	.30	21	2.20	.72	.32	.30					
11	.....	.72	.40	.30	22	2.20	.72	.32	.30					

CACHE LA POUDRE RIVER NEAR FORT COLLINS, COLORADO.

This stream is the northernmost of the large tributaries of the South Platte which issue from the east front of the Rocky Mountains. During the irrigating season its discharge is augmented by the supply diverted from the headwaters of Laramie River, which lie immediately to the west of the headwaters of the Cache la Poudre, the diversion being made through Sky Line canal. Measurements of the discharge of the Cache la Poudre Basin, therefore, include some of the Laramie waters. Practically the entire flow of the Cache la Poudre is used for irrigation purposes, even the greater part of the flood waters being stored for use later in the season. It is along the valley of the Cache la Poudre that the earliest and best irrigation of the State has been carried on.

The gaging station, which was established in 1884, is about 15 miles above Fort Collins. Since its establishment it has been maintained under the direction of Prof. L. G. Carpenter, of the Colorado State Agricultural College. The records are from the figures published by Professor Carpenter in the daily papers. The figures of daily discharge for the years 1895 to 1899, inclusive, will be found in Water-Supply Paper No. 37, pages 235 to 237.

Daily discharge, in second-feet, of Cache la Poudre River near Fort Collins, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2,551	3,951	1,360	369	204	140
2	.....	2,508	3,938	1,276	355	199	137
3	.....	2,447	4,080	1,176	341	160	122
4	.....	2,251	3,600	1,042	374	143	122
5	.....	2,461	3,104	958	460	133	122
6	.....	2,354	3,602	871	435	126	122
7	.....	2,447	4,376	853	392	124	122
8	.....	2,486	4,227	827	315	137	122
9	.....	2,586	4,193	795	299	183	122
10	.....	2,777	4,180	752	292	260	141
11	.....	3,012	3,224	705	276	255	141
12	.....	2,992	2,978	666	260	151	141
13	.....	2,811	2,813	641	247	157	141
14	.....	2,652	3,001	625	235	156	141
15	.....	2,411	2,797	597	214	144	141
16	.....	2,049	2,968	599	218	138	141
17	.....	2,143	2,923	576	218	133	.....
18	427	2,258	2,622	531	218	126	.....
19	556	2,093	2,789	525	214	118	.....
20	823	2,271	2,567	525	212	113	.....
21	1,168	2,582	2,573	481	210	122	.....
22	1,554	2,525	2,441	460	248	122	.....
23	1,245	2,490	2,460	475	195	121	.....
24	1,263	2,884	2,329	736	200	121	.....
25	1,223	2,939	2,140	767	198	126	.....
26	1,154	3,240	2,036	719	215	141	.....
27	1,204	3,561	1,813	641	212	144	.....
28	1,807	4,071	1,674	592	201	140	.....
29	2,934	4,560	1,540	558	204	140	.....
30	2,530	4,416	1,325	527	199	141	.....
31	.....	4,204	.....	506	204	.....	.....
Mean	1,376	2,808	2,942	721	265	149	132

[Continued in Water-Supply Paper No. 50, where will be found tables of computations of seepage on numerous streams in Colorado.]

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56TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 534.

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 50

OPERATIONS AT RIVER STATIONS, 1900.—PART IV

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1900

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART IV

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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OPERATIONS AT RIVER STATIONS, 1900.

PART IV.

MEASUREMENTS AT RIVER STATIONS.[1]

COMPUTATIONS OF SEEPAGE IN COLORADO.

Discharge measurements of a number of the principal rivers in Colorado, including South Platte River and its tributaries, also Arkansas and Uncompahgre rivers, have been made during low-water stages for several years past under the direction of the agricultural experiment station at Fort Collins, Colorado. It has been known for a number of years that a large amount of seepage water returned to the rivers from irrigated areas adjacent to them, and these measurements were instituted in order to determine the amount of this returned water. A report of the investigations up to 1896 was given in Bulletin No. 33 of the Colorado State Agricultural College. Annual measurements have been made since that time, and it is the intention of the college authorities to publish the complete results in an additional bulletin, which will appear shortly. The conclusions reached from these measurements, together with the following tables of the results of the measurements made in 1900, are taken from the tenth biennial report of the State engineer of Colorado, pages 210–236:

1. There is a real increase in the volume of the streams as they pass through the irrigated sections.
2. There is no such increase in the streams as they pass through the unirrigated sections. On the contrary, there is an actual loss, even when the drainage of a large area enters.
3. The increase is more as the irrigated area is greater.
4. The increase is approximately proportional to the irrigated area, and it seems probable that with more intimate knowledge of the amount of water applied and the features of the drainage the proportions would be found to be close.
5. The amount of the increase depends very slightly, if at all, upon the rainfall, and so far as it does it is influenced principally by the rainfall on the irrigated lands. Only where the lands are already saturated is the rainfall sufficient to cause seepage.

[1] Continued from Water-Supply and Irrigation Paper No. 49.

6. There is no perceptible underflow from the side channels, even where they drain several thousand square miles.

7. The inflow is practically the same throughout the year. It is more in summer, less in winter, principally because of the effect of the temperature of the soil.

8. The passage of the seepage water through the soil is very slow, so that it may take years for the seepage from the outlying lands to reach the river.

9. The amount of seepage is slowly but constantly increasing.

10. It may be expected to increase for some years to come.

11. An increased amount of land may be brought under cultivation with time, more especially on the lower portions of the streams.

12. The seepage being nearly constant throughout the year, while the needs are greatest in summer, the use of storage will best utilize the water from inflow.

13. On the Poudre River about 30 per cent of the water applied in irrigation returned to the river.

14. The use of water on the upper portions of a stream, when water is not immediately needed by prior appropriators, will increase the flow of the stream late in summer, and prevent such low stages as it would have without this regulating action.

15. The seepage water is already an important factor in the water supply for the agriculture of the State. The capital value of the water thus received in the valley of the Cache la Poudre alone is not less than $300,000, and perhaps $500,000, and for the Platte is from $2,000,000 to $3,000,000. It is large for the other streams, but of unknown amount.

16. An actual loss is incurred in carrying a stream like the Platte through sandy beds.

17. Ultimately the returns from seepage will make the lower portions of such valleys as the Platte more certain of water, and probably enable a larger acreage to be grown.

Computations of seepage on South Platte River, Colorado, 1899.

Date.	Stream or ditch.	In river.	Diverted by canals.	Inflow.	Amount in river + amount diverted and − inflow.	Increase in volume of river between points measured.	Increase from canyon to point where last measured.
		Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Oct. 23	South Platte River at canyon	154.49					
Do	High Line canal		131.59				
Do	Denver Union Water Company's canal		22.00				
Oct. 24	Platte Canyon ditch		32.60				
Do	Wasteway of Platte Canyon ditch			7.50			
Do	Last Chance ditch		2.82				
Do	City ditch		18.83				
Do	South Platte River below City ditch	27.08			227.42	72.93	
Do	Plum Creek			4.45			
Do	Deer Creek			1.78			
Do	Nevada ditch		21.73				
Do	South Platte River at Littleton	60.08			88.04	60.96	133.89
Oct. 26	do	55.29					
Do	Bear Creek			13.41			
Do	Ditch		0.19				
Do	Seepage stream			a 3.86			
Do	Clark Gulch			a 10.87			
Do	South Platte River at Fifteenth street bridge, Denver	84.91			71.69	16.40	150.29
Oct. 27	do	88.90					
Do	Farmers and Gardeners' ditch		4.47				
Do	Burlington ditch		89.30				

Computations of seepage on South Platte River, Colorado, 1899—Continued.

Date.	Stream or ditch.	In river.	Diverted by canals.	Inflow.	Amount in river + amount diverted and — inflow.	Increase in volume of river between points measured.	Increase from canyon to point where last measured.
		Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Oct. 27	Clear Creek			0.18			
Do	Fulton ditch		38.87				
Do	South Platte River (city waste included)	54.67			135.51	46.61	196.90
Oct. 28	Brantner ditch below head of Fulton		45.75				
Do	Brighton ditch		5.02				
Do	South Platte River at bridge west of Brighton	81.38			132.15	77.48	274.38
Do	Dry Creek			a 23.81			
Do	Platteville ditch		4.60				
Do	South Platte River below head of Platteville ditch	126.73			131.33	49.95	324.33
Oct. 30	Evans No. 2 ditch		14.94				
Do	Side Hill and Meadow Island No. 2		1.00				
Do	Bucker		7.20				
Do	South Platte River	140.75			155.49	38.76	303.09
Do	Cook & Hewes ditch		12.30				
Do	St. Vrain Creek			94.91			
Oct. 31	South Platte River below Union ditch	270.87			188.35	47.65	410.74
Do	Big Thompson Creek			39.49			
Do	Section No. 3 ditch		12.60				
Do	Lower Latham ditch		26.73				
Do	South Platte River at Evans bridge	334.88			334.72	63.85	474.59
Nov. 1	Cache la Poudre River			151.01			
Do	Lone Tree Creek			5.49			
Do	Sterling seepage		5.59				
Do	South Platte River below Hoover	575.27			424.36	89.48	564.07
Nov. 2	Boxelder Creek			6.79			
Do	Harden ditch		5.62				
Do	Latham waste			5.42			
Do	Corona ditch		4.57				
Do	South Platte River at head of Putnam ditch	638.19			636.17	60.90	624.97
Do	Putnam ditch		8.61				
Nov. 3	Weldon Valley ditch		18.85				
Do	South Platte River at Orchard bridge	613.98			641.44	3.25	628.22
Nov. 4	South Platte River at Shaffer's ford	701.33			701.33	87.35	715.57
Do	Bijou Creek			4.00			
Do	Dueul & Snyder ditch		9.69				
Do	South Platte River at Fort Morgan bridge	702.78			712.47	7.14	722.71
Do	Platt ditch		13.41				
Nov. 5	Platte and Beaver ditch		5.00				
Do	A. A. Smith ditch		15.74				
Do	South Platte River at Snyder bridge	741.26			775.41	72.63	795.34
Nov. 6	Johnson & Edwards ditch		29.75				
Do	Tetsel ditch		9.67				
Nov. 7	South Platt ditch		27.58				
Do	Davis Brothers' ditch		28.63				
Do	Pawnee ditch		96.78				
Do	South Platte River at Merino bridge	552.72			835.13	93.87	889.21
Do	Sterling No. 1 ditch		21.98				
Do	Sterling No. 2 ditch		13.72				
Nov. 8	Smith & Henderson ditch		11.59				
Do	South Platte River at Sterling bridge	581.16			628.45	75.73	962.94
Nov. 9	Low Line ditch		54.82				
Do	Iliff ditch		5.14				
Do	South Platte River at Iliff bridge	567.39			627.35	46.19	1,009.13
Do	Harmony No. 1 ditch		38.79				
Do	Harmony No. 2 ditch		15.02				
Do	South Platte River at Crook	582.96			636.77	69.38	1,078.51
Nov. 11	Peterson ditch		110.28				
	South Platte River above Pole Creek	445.55			555.83	b 17.13	
Nov. 12	South Platte River at State line	486.78			486.78	41.23	1,119.74

a Seepage not included in natural flow. b Decrease.

Computations of seepage on South Platte River, Colorado, 1900.

Date.	Stream or ditch.	In river.	Diverted by canals.	Inflow.	Amount in river + amount diverted and − inflow.	Increase in volume of river between points measured.	Increase from canyon to point where last measured.	Distance between points.	Increase in volume per mile.
		Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Miles.*	*Sec.-ft.*
Oct. 19	High Line canal		73.30						
	South Platte River below High Line waste	97.85							
	Platte Canyon ditch		55.30						
	Last Chance ditch		14.70						
	City ditch		30.00						
Do.	South Platte River	31.81			131.81	33.96	33.96	6.0	5.66
Oct. 20	Plum Creek			3.07					
Do.	Deer Creek			23.54					
Do.	Nevada ditch		13.48						
Do.	Lee Gulch			*a* 0.75					
Do.	Clark Gulch			*a* 0.503					
Do.	Dutch Gulch			1.11					
Do.	Nevada ditch waste			3.167					
Do.	South Platte River at lower Littleton bridge	89.394			71.98	40.17	74.13	6.0	6.69
Do.	Big Dry Creek seepage			0.96					
Do.	Little Dry Creek			12.43					
Do.	Bear Creek			10.83					
Do.	Denver Union Water Co.'s canal		15.47						
Do.	South Platte River at Fifteenth street, Denver	113.40			105.61	16.22	90.35	10.0	1.62
Oct. 22	do	161.26							
Do.	Farmers and Gardeners' ditch		5.10						
Do.	City sewer			61.42					
Do.	Burlington ditch		121.72						
Do.	Farmers and Gardeners' ditch waste			3.73					
Do.	Heller ditch		2.11						
Do.	Clear Creek			1.40					
Do.	South Platte River at approach to Fulton ditch	95.50			157.87	*b* 3.39	86.96	11.0	*b* 0.31
Oct. 23	do	76.82							
Do.	Fulton ditch		51.73						
Do.	Stream flows into Fulton ditch			0.68					
Do.	Brighton ditch		16.92						
Do.	South Platte River at Brighton bridge	81.83	68.65		150.48	73.66	160.62	7.0	10.52
Do.	Dry Creek			15.17					
Do.	Platteville ditch		18.80						
Do.	McCann seepage ditch			*c* 4.0					
Do.	South Platte River	112.06	18.80	15.17	115.69	33.80	194.48	8.0	4.23
Do.	Evans No. 2 ditch		48.38						
Oct. 24	Beaman and Meadow Island ditches		17.72						
Do.	Independent ditch		23.70						
Do.	South Platte River	44.48	89.80		134.28	22.22	216.70	8.0	2.78
Do.	Cook & Hewes ditch		16.17						
Do.	Seepage to Cook & Hewes ditch		2.00						
Do.	St. Vrain Creek		52.57						
Do.	South Platte River below Union ditch	121.94	16.17	52.57	85.54	41.06	257.76	9.0	4.56
Do.	Section No. 3 ditch		2.62						
Do.	Big Thompson Creek			16.78					
Do.	Lower Latham seepage ditch			*c* 20.07					
Do.	Lower Latham ditch		19.56						
Do.	South Platte River at Evans bridge	192.58	22.18	16.78	197.98	76.04	333.80	7.5	10.14
Oct. 25	Poudre River			84.69					
Do.	Lone Tree Creek			1.87					
Do.	Sterling seepage ditch	4.65							
Do.	South Platte River at Kersey bridge	298.77		86.56	212.21	19.63	353.43	6.0	3.27
Do.	Boxelder Creek			6.78					

a Seepage gaged for record only. *b* Decrease. *c* Now enters river.

Computations of seepage on South Platte River, Colorado, 1900—Continued.

Date.	Stream or ditch.	In river.	Diverted by canals.	Inflow.	Amount in river + amount diverted and − inflow.	Increase in volume of river between points measured.	Increase from canyon to point where last measured.	Distance between points.	Increase in volume per mile.
		Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Miles.*	*Sec.-ft.*
Oct. 26	South Platte River at Hardin Station	361.20		6.78	354.42	55.65	409.08	8.0	6.96
Do	Latham waste			0.54					
Do	Corona ditch		4.13						
Do	Schultz ditch		11.58						
Do	South Platte River above Putnam ditch	349.89	15.71	0.54	65.06	3.86	412.94	12.0	0.32
Do	Putnam ditch		7.50						
Do	Weldon Valley ditch		45.20						
Oct. 27	South Platte River at Orchard Station	323.78	52.71		376.49	26.60	439.54	8.5	3.13
Do	Fort Morgan canal	238.01							
Do	South Platte River	115.24			353.25	29.47	469.01	9.0	3.27
Do	Dueul & Snyder ditch		5.64						
Do	Upper Platte and Beaver ditch		116.72						
Do	Platt ditch		22.55						
Do	South Platte River	14.05	144.91		158.96	43.72	512.73	9.0	4.86
Oct. 29	Lower Platte and Beaver ditch		46.15						
Do	A. A. Smith ditch		25.19						
Do	South Platte River at Snyder	26.48	71.34		97.82	83.77	596.50	11.0	7.62
Do	Johnson & Edwards ditch		23.26						
Do	Tetsel ditch		19.52						
Oct. 30	South Platte ditch		a 23.57						
Do	Pawnee ditch		24.50						
Do	Davis Brothers' ditch		2.78						
Do	South Platte River at Merino bridge	18.39	93.63		112.02	85.54	682.04	18.0	4.75
Do	Snyder ditch		7.26						
Do	Springdale ditch		31.86						
Do	Sterling No. 1 ditch		11.40						
Oct. 31	South Platte River at Sterling bridge	29.90	50.52		80.42	62.06	744.07	13.75	4.51
Do	Bravo ditch		28.50						
Do	Cedar Creek			0.50					
Do	South Platte River at Iliff bridge	27.71	28.50	0.50	55.71	5.19	749.26	11.75	0.44
Nov. 1	South Platte River at Crook bridge	51.35				23.64	772.90	17.0	1.39
Do	South Platte River at Sedgwick bridge	50.66				b 0.69	772.21	15.0	0.04
Nov. 2	South Reservation ditch at State line		2.47						
Nov. —	Lodgepole Creek			0.18					
Nov. 2	South Platte River at State line	76.35	2.47	0.18	78.64	27.96	800.19	17.0	1.65

a All water taken by this ditch. b Decrease.

Computations of seepage.

BEAR CREEK, COLORADO, 1900.

Date.	Locality.	In river.	Diverted by canals.	Inflow.	Section gain or loss.	Total gain or loss.
		Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
October 27	Above Morrison dam	24.06				
Do	Below Morrison dam	6.57	9.69	0.23		
Do	Below Pioneer Union ditch	0.81	0.23		3.70	3.70
Do	County line	10.11	8.64	0.69	9.53	13.23
Do	Near mouth	4.64			2.48	15.71

CLEAR CREEK, COLORADO, 1900.

October 29	Three-fourths mile above Golden	27.39	20.94	0.49		
Do	Below Rocky Mountain ditch	4.46			−2.48	−2.48
October 30	do	10.56	1.75			
Do	Near where river branches	16.83	0.93		8.02	5.54
Do	Near junction of river	20.26			4.36	9.90
November 17	do	13.87	17.39			
Do	Below Clear Creek and Platte River ditch	0.23		0.49	3.75	13.65
Do	At mouth	2.87			2.15	15.80

SOUTH BOULDER CREEK, COLORADO, 1900.

	Gaging station	9.24	7.44			
	Below Dry Creek ditch	2.63	2.68		0.93	0.93
	One-half mile above mouth	0.07			0.12	1.05

BOULDER CREEK, COLORADO, 1900.

October 24	Gaging station	29.25	5.05			
Do	Valmont bridge	14.24	28.64		13.63	13.63
Do	Leggett's Crossing	18.10			3.86	17.49
October 25	do	9.97	11.98			
Do	Plumb Crossing, county line	9.59			11.60	29.09
Do	One-half mile above mouth	1.04	7.06		−1.49	27.60

ST. VRAIN CREEK, COLORADO, 1900.

October 17	South of Lyons	66.24	39.04			
Do	Below Oligarchy ditch	21.44	31.65	9.37	− 5.76	− 5.76
October 18	Below Ni Wot ditch	2.01	1.77	16.99	2.85	− 2.91
Do	Near County Line	31.95			14.72	11.81
October 19	do	25.55				
Do	Near mouth of Boulder Creek	36.02	5.41	13.09	10.47	22.28
Do	At Fleming bridge	49.28			5.58	27.86
Do	Near mouth	57.83			8.55	36.41

LEFT HAND CREEK, COLORADO, 1900.

October 20	Below Johnson ditch	3.92	4.37			
Do	Below Holland ditch	0.80	0.41		1.25	1.25
Do	At Williamson ditch				− 0.39	0.86
Do	One mile west of Burch School	0.18			0.18	1.04
Do	Near mouth	6.19			6.01	7.05

Computations of seepage—Continued.

LITTLE THOMPSON CREEK, COLORADO, 1900.

Date.	Locality.	In river.	Diverted by canals.	Inflow.	Section gain or loss.	Total gain or loss.
		Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
September 15	Below Eagle ditch	0.74		0.02		
Do	Below mouth of Dry Creek	2.67	4.42		1.91	1.91
Do	Rockwell bridge	3.34			5.19	8.10
September 16	do	3.31	3.75			
Do	Below Minor & Langdon ditch	3.45		0.53	3.89	11.99
Do	Graham bridge	11.10	9.08		7.65	19.54
Do	Near mouth	5.30			3.28	22.82

BIG THOMPSON CREEK, COLORADO, 1900.

July 21	Below dam	104.76	157.16			
Do	At Langston's	86.12	28.50	1.68	8.18	8.18
July 20	do	104.16				
Do	Below L. & G. canal	99.87	46.23	35.67	6.27	14.45
Do	Above Farmers' ditch	76.84	19.55	0.06	− 3.54	10.91
July 19	do	69.80				
Do	Lytle bridge	21.61	47.10		− 1.09	9.82
Do	Below Hill & Brush ditch	26.32	5.51	2.24	7.98	17.80
Do	Ring place	30.58				
July 18	do	28.91				
Do	Below Big Thompson and Platte River ditch.	10.39	23.06		8.80	26.60
Do	Near mouth	28.76	26.08	14.20	25.25	51.85
September 18	Below dam at Chasten's	30.28	49.45			
Do	At Langston's	29.21	10.40	0.66	8.67	8.67
September 17	Below L. & G. dam	28.78	6.86	16.71	−10.28	− 1.61
Do	Below Farmers' ditch	34.45	8.35		9.02	7.41
Do	Lytle bridge	3.24	31.27		0.06	7.47
September 9	do	2.27	1.72	1.62		
Do	Below Hill & Brush ditch	5.18			3.01	10.48
September 8	do	4.67	6.99			
Do	Below Big Thompson and Platte River ditch.	2.77	12.64	4.26	5.09	15.57
Do	Near mouth	5.89			11.50	27.07

CACHE LA POUDRE RIVER, COLORADO, 1900.

August 2	At weir	308.85	197.13	0.39		
Do	Above new Mercer ditch	117.19			5.08	5.08
August 3	do	138.02	105.80	53.20		
Do	Below Larimer & Weld dam	82.29			− 3.13	1.95
July 12	do	146.88	76.79	64.79		
Do	Below No. 2 Reservoir Supply ditch.	120.11			−14.77	−12.82
July 13	do	112.93	2.53	159.97		
Do	Strauss bridge	221.62			− 3.74	−16.56
July 14	do	235.02	138.00			
Do	Below No. 2 dam	80.18	34.38		−16.84	−33.40
Do	Below Eaton ditch	51.43			5.63	−27.77
July 16	do	65.94	62.58	3.00		
Do	Below Greeley No. 3 dam	12.66	6.27		6.30	−21.47
July 17	Mill power canal	37.55	59.25	1.23	30.17	8.70
Do	Below Camp ditch	13.83			34.29	42.99
Do	One-fourth mile above mouth	57.22			43.39	86.38
September 4	At weir in canyon	118.32	117.83			
Do	Below Collins waterworks dam	4.87	34.24	25.22	4.38	4.38
September 5	Below Larimer & Weld dam				4.15	8.53
September 30	do	15.02	13.24	0.52		
Do	Below No. 2 Reservoir Supply ditch.	5.74			3.56	12.09
Do	Above head of Boxelder ditch	11.09			5.35	17.44
September 31	do	8.67	3.06			
Do	Strauss bridge	11.75	0.97		6.14	23.58
Do	Below No. 2 canal dam	12.15			1.37	24.95
September 5	do	9.87	6.97			
Do	Below Eaton ditch	5.93			3.03	27.98
September 6	do	6.29	20.07	15.44		
Do	Below Greeley No. 3 dam	2.96	5.93		1.30	29.28
Do	Below Greeley power canal	18.43			21.40	50.68
September 7	do	18.75	33.64	0.18		
Do	Below Camp ditch	9.78			24.49	75.17
Do	Near mouth	44.63			34.85	110.02

Computations of seepage—Continued.

RIO GRANDE, COLORADO, 1900.

Date.	Locality.	In river.	Diverted by canals.	Inflow.	Section gain or loss.	Total gain or loss.
		Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
August 30	Railroad station at South Fork	194.24	33.41	0.85		
August 31	U. S. Geol. Survey gaging station.	209.83			48.15	48.15
August 20	do	249.06	146.61			
Do	Above Del Norte canal	176.50			−25.95	22.50
August 21	do	178.90	32.11			
Do	At Off's	168.48			21.69	43.89
August 22	do	156.22	47.19			
Do	Below Prairie canal	99.29		0.31	−10.05	33.84
August 23	do	108.91	96.00	4.33		
Do	Below Monte Vista bridge	14.00			− 3.24	30.60
August 24	do	14.30	30.29			
Do	Below San Luis canal	5.90	14.24	5.21	21.89	52.49
Do	Below Hickory-Jackson ditch	10.65			13.98	66.47
August 25	do	11.55	10.69			
Do	Below Alamosa	1.00			0.14	66.61
August 27	do	1.01				
Do	Above mouth of Conejos River	1.35		14.33	0.24	66.85
Do	Below Conejos, north branch	15.33		6.90	− 0.35	66.50
Do	Below La Sauses	23.98			1.75	68.25
August 28	do	22.31				
Do	Above State bridge	17.22			− 5.09	63.16

CONEJOS RIVER, COLORADO, 1900.

August 31	At State gaging station	24.65				
Do	Above San Juan bridge	24.77	1.97		2.09	
Do	At bridge	0.50	2.15		−22.12	−20.03
August 30	Above Cerritos	0.80		0.77	0.30	−19.73
Do	Below San Antonio Creek	0.55	3.32		− 1.02	−21.75
Do	At McIntire place	3.88			6.65	−14.10
August 29	do	4.33	24.00			
Do	Below McIntire spring	31.33	14.19		3.00	−11.10
Do	Two hundred feet above bridge	24.02			6.88	− 4.22

UNCOMPAHGRE RIVER, COLORADO, 1900.

November 1	At Batchelor switch	32.04	6.17	2.40		
Do	One-half mile below eleventh corner line.	29.87	1.44	3.21	1.10	1.10
Do	Near Ridgway	54.42			23.28	24.38
November 2	do	57.64	2.42	35.58		
Do	Six and one-half miles below Ridgway.	88.15	12.32	1.98	− 2.65	21.73
Do	County Line	88.91			11.10	32.83
November 3	do	92.11	50.00	0.50		
Do	Stark bridge, near Montrose	52.94	40.63		10.33	43.16
November 4	Bridge at Montrose	12.22	17.37		− 0.09	43.07
Do	Above Spring Creek	14.28	23.17	7.43	19.43	62.50
November 5	Wagon bridge, Olathe	14.51	10.47		15.97	78.47
Do	Below Boles & Mauny ditch		5.78		− 4.04	74.43
Do	One-half mile above mouth	8.45			14.23	88.66

LOUP RIVER NEAR COLUMBUS, NEBRASKA.

This station is located near the iron bridge of the Union Pacific Railway just west of Columbus, Nebraska, and only a short distance above the mouth of the river. It is described in Water-Supply Paper No. 37, page 240. Results of measurements for 1899 will be found in

the Twenty-first Annual Report, Part IV, page 214. During 1900 the following discharge measurements were made by Adna Dobson:

Discharge measurements of Loup River near Columbus, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 8	4.69	2,365	August 12	4.44	1,935
April 27	5.20	4,455	August 26	4.40	2,582
May 13	4.68	2,772	September 16	5.00	3,077
May 27	4.67	2,509	October 7	4.55	2,294
June 10	4.53	2,161	October 31	4.86	3,246
June 20	4.05	2,491	November 30	4.53	3,542
July 15	3.93	1,705	December 19	4.44	2,674
July 29	4.38	1,322			

Daily gage height, in feet, of Loup River near Columbus, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	4.75	5.10	4.85	3.78	4.43	4.15	4.45	4.70
2	4.75	5.00	4.70	3.90	4.43	4.20	4.45	4.65
3	4.75	4.95	4.50	3.87	4.32	4.23	4.48	4.60
4	4.75	4.96	4.85	4.54	4.28	4.23	4.48	4.48
5	4.75	4.98	4.87	4.28	4.25	4.25	4.50	4.48
6	4.75	4.95	4.82	4.93	4.25	4.25	4.50	4.45
7	4.75	4.98	4.75	4.46	3.98	4.25	4.55	4.40
8	4.71	5.32	4.65	4.62	4.05	4.27	4.55	4.43
9	4.70	5.30	4.55	4.70	4.63	4.27	4.58	4.45
10	4.72	5.00	4.53	4.40	4.68	4.28	4.60	4.48
11	4.74	4.95	4.65	4.35	4.55	5.98	4.58	4.55
12	4.70	4.95	4.65	4.20	4.44	5.25	4.58	4.55
13	4.80	5.68	4.62	4.15	4.48	5.45	4.58	4.59
14	4.81	5.20	4.61	3.98	4.43	5.63	4.58	4.55
15	4.80	5.14	4.65	3.93	4.63	5.48	4.57	4.55
16	4.82	5.05	4.65	4.28	5.53	5.00	4.57	4.50
17	4.85	5.03	6.28	4.73	5.83	4.70	4.56	a4.58
18	4.87	5.01	5.20	4.78	5.50	4.48	4.55	.....
19	4.90	5.00	4.85	4.55	5.38	4.48	4.60	.....
20	5.00	4.95	3.98	4.38	4.48	4.45	4.66	.....
21	5.30	4.75	3.95	4.35	4.42	4.48	.....	.....
22	5.30	4.72	4.10	4.43	4.38	4.48	.....	.....
23	5.30	4.71	3.85	4.45	4.32	4.50	.....	.....
24	5.32	4.70	3.87	4.98	4.35	4.48	.....	.....
25	5.27	4.60	3.83	5.05	4.50	4.48	.....	.....
26	5.26	4.65	3.88	5.00	4.57	4.48	.....	.....
27	5.25	4.90	3.85	4.40	4.70	4.50	.....	.....
28	5.25	4.80	3.83	4.50	4.68	4.48	5.00	.....
29	5.20	4.82	3.83	4.38	4.53	4.48	5.00	.....
30	5.20	4.70	3.80	4.35	4.35	4.40	4.81	.....
31	.....	6.65	.....	4.35	4.28	.....	4.76	.....

a Closed for winter November 17.

PLATTE RIVER NEAR COLUMBUS, NEBRASKA.

This station, which was established in 1895, is located above Meridian Bridge, south of Columbus. It is described in Water-Supply Paper No. 37, page 242. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 215. During 1900 the following discharge measurements were made by Adna Dobson:

Discharge measurements of Platte River near Columbus, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 8	2.68	1,907	July 29	0.98	394
April 29	4.58	15,673	August 26	.86	149
May 13	5.05	21,827	September 16	1.07	403
May 27	4.90	18,557	October 31	1.72	998
June 10	4.95	15,696	November 30	1.17	317
June 24	4.30	12,519	December 19	2.33	569
July 15	2.06	1,456			

Daily gage height, in feet, of Platte River near Columbus, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		4.00	4.45	3.30	0.10	(a)	(a)	1.60
2		3.95	4.55	3.38	(a)	(a)	(a)	1.48
3		3.94	4.69	3.32	(a)	(a)	(a)	1.37
4		3.95	4.70	3.33	(a)	(a)	(a)	1.25
5		4.65	4.66	3.87	(a)	(a)	(a)	1.23
6		4.68	4.75	3.38	(a)	(a)	(a)	1.20
7		5.60	5.05	2.95	(a)	(a)	(a)	1.16
8	2.69	5.30	5.00	2.87	(a)	(a)	(a)	1.10
9	2.65	5.20	4.95	3.02	(a)	(a)	(a)	1.03
10	2.64	5.20	4.95	3.00	(a)	(a)	(a)	(b)
11	2.64	5.30	5.10	2.73	(a)	2.78	(a)	(b)
12	2.64	5.30	4.95	2.43	(a)	2.25	(a)	(b)
13	2.64	5.05	4.85	2.20	(a)	2.05	(a)	(b)
14	2.64	5.05	4.80	2.10	(a)	1.80	(a)	(b)
15	2.63	5.00	4.95	3.06	(a)	1.48	(a)	(b)
16	2.64	4.95	5.20	3.23	0.03	1.07	(a)	(b)
17	2.68	4.90	5.34	2.30	(a)	1.61	(a)	(b)
18	3.50	4.90	4.96	1.83	(a)	(a)	(a)	.....
19	3.80	4.80	5.00	1.86	(a)	(a)	(a)	.....
20	3.70	4.75	4.90	1.98	(a)	(a)	(a)	.....
21	3.60	4.95	4.82	2.00	(a)	(a)	(a)	.....
22	3.95	5.10	4.60	1.43	(a)	(a)	(a)	.....
23	3.96	5.40	4.42	1.50	(a)	(a)	(a)	.....
24	3.98	5.30	4.30	1.75	(a)	(a)	1.70	.....
25	4.00	5.00	4.20	1.43	0.70	(a)	1.70	.....
26	4.10	4.95	3.96	1.50	.70	(a)	1.70	.....
27	4.25	4.90	3.90	1.65	.53	(a)	1.60	.....
28	4.45	4.70	3.74	1.63	.28	(a)	1.55	.....
29	4.63	4.50	3.60	.98	.03	(a)	1.50	.....
30	4.30	4.45	3.55	.85	.....	(a)	1.45	.....
31	.....	4.40	.....	.50	.....	.....	1.66	.....

a No water at gage; all in small channels. *b* Frozen. Closed for winter November 17.

ELKHORN RIVER NEAR NORFOLK, NEBRASKA.

Two gaging stations are maintained on this river, one at Norfolk and the other at Arlington, Nebraska. The station at the former place is at the Thirteenth street bridge, 2 miles south of the town and above the mouth of the North Fork of Elkhorn River. It is described in Water-Supply Paper No. 37, page 243. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 217. During 1900 the following discharge measurements were made by O. V. P. Stout:

Discharge measurements of Elkhorn River near Norfolk, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 20	2.43	568	June 29	1.38	223
May 4	3.65	1,207	Do	1.38	244
May 27	.....	463	August 3	1.23	150
Do	2.03	407	September 12	1.66	318

Daily gage height, in feet, of Elkhorn River near Norfolk, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.89	3.56	2.09	1.34	1.28	1.35	1.32	1.86
2	1.87	3.62	2.15	1.35	1.26	1.30	1.33	1.85
3	1.80	3.62	2.20	1.34	1.24	1.29	1.35	1.82
4	1.78	3.67	2.03	1.30	1.20	1.34	1.34	1.81
5	1.78	3.65	1.99	1.33	1.21	1.35	1.34	1.82
6	1.77	3.67	1.85	1.32	1.16	1.27	1 34	1.81
7	1.76	3.58	1.87	1.23	1.16	1.25	1.36	1.81
8	1.71	3.40	1.80	1.23	1.15	1.25	1.34	1.82
9	1.83	3.24	1.60	1.25	1.14	1.24	1.34	1.82
10	1.87	3.25	1.69	1.22	1.10	1.25	1.35	1.80
11	1.79	2.95	1.99	1.10	1.04	1.55	1.35	1.82
12	1.83	2.84	1.80	1.15	1.13	1.58	1.32	1.75
13	1.80	2.76	1.61	1.13	1.14	1.52	1.31	1.74
14	1.79	2.62	1.60	1.13	1.20	1.49	1.35	1.76
15	1.84	2.59	1.53	1.62	1.30	1.47	1.35	1.76
16	1.97	2.52	1.58	1.62	1.97	1.45	1.34	1.74
17	2.57	2.52	1.57	1.55	1.67	1.42	1.35	*a* 1.75
18	2.40	2.37	1.50	1.63	1.65	1.38	1.35	.....
19	2.39	2.32	1.50	1.62	1.68	1.42	1.34	.....
20	2.42	2.24	1.50	1.52	1.71	1.46	1.36	.....
21	2.42	2.17	1.57	1.52	1.62	1.46	1.62	.....
22	2.48	2.13	1.57	1.52	1.52	1.38	1.75	.....
23	2.66	2.11	1.49	1.53	1.48	1.42	1.97	.....
24	2.99	1.95	1.47	1.53	1.39	1.41	1.85	.....
25	3.02	1.95	1.45	1.52	1.42	1.42	1.85	.....
26	3.10	2.02	1.39	1.39	1.48	1.35	1.83	.....
27	3.31	1.96	1.34	1.41	1.53	1.33	1.86	.....
28	3.48	1.93	1.34	1.39	1.53	1.35	1.85	.....
29	3.68	1.83	1.36	1.42	1.46	1.35	1.85	.....
30	3.54	1.86	1.35	1.34	1.42	1.33	1.90	.....
31	.....	1.85	.....	1.30	1.35	.....	1.91	.....

a Closed for winter November 17.

ELKHORN RIVER NEAR ARLINGTON, NEBRASKA.

This station, which was established by Glenn E. Smith on April 28, 1899, is located at the wagon bridge 1 mile west of the town of Arlington. It is described in Water-Supply Paper No. 37, page 244. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 218. During 1900 the following discharge measurements were made by O. V. P. Stout:

Discharge measurements of Elkhorn River near Arlington, Nebraska.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 19	2.06	685	August 2	1.26	452
May 5	3.25	1,411	Do	1.26	431
Do	3.25	1,458	August 14	1.15	441
June 1	1.80	693	Do	1.15	415
Do	1.80	723	September 12	4.74	2,855
June 28	1.25	465	November 14	2.05	769
Do	1.25	468			

Daily gage height, in feet, of Elkhorn River near Arlington, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.76	3.59	1.81	0.97	1.37	2.14	1.94	3.82
2	1.75	3.51	1.87	.95	1.24	1.75	1.84	3.88
3	1.76	3.40	1.75	.98	1.16	1.52	1.82	3.75
4	1.74	3.33	1.93	.96	1.08	1.38	1.74	3.60
5	1.67	3.24	1.88	1.18	1.06	1.31	1.70	3.40
6	1.65	3.18	1.90	1.09	.99	1.27	1.65	3.15
7	1.61	3.22	1.92	1.02	.93	1.25	1.60	2.80
8	1.60	3.35	1.81	.99	.88	1.23	1.56	2.63
9	1.56	3.56	1.68	.92	.82	1.25	1.53	2.39
10	1.59	4.18	1.66	.88	.78	1.16	1.49	2.26
11	1.57	4.00	1.62	.91	.80	1.54	1.47	2.21
12	1.56	3.33	1.56	.85	.88	2.56	1.45	2.18
13	1.56	2.98	1.63	.84	.92	5.80	1.42	2.14
14	1.57	2.80	2.31	.76	1.18	5.70	1.39	2.07
15	1.60	2.70	1.60	.76	1.90	5.41	1.36	2.02
16	1.64	2.61	1.53	1.48	1.91	4.43	1.33	1.98
17	1.72	2.55	1.72	1.24	1.72	4.00	1.30	1.90
18	1.98	2.51	1.77	1.15	2.10	3.67	1.28	1.90
19	2.05	2.35	1.58	1.30	2.95	3.48	1.29	1.91
20	2.17	2.27	1.54	1.58	2.66	3.31	1.31	1.86
21	2.46	2.19	1.50	1.56	2.37	3.26	1.32	1.79
22	2.55	2.13	1.42	2.04	2.13	3.32	1.72	1.65
23	2.56	1.85	1.34	2.47	2.26	3.30	1.91	1.59
24	2.66	1.84	1.29	3.01	2.04	3.04	1.98	a 1.54
25	2.67	1.77	1.25	2.72	1.96	2.89	2.06	.....
26	2.75	1.75	1.27	2.56	2.17	3.11	2.18	.....
27	2.75	1.88	1.36	2.35	2.12	2.66	2.26	.....
28	2.93	1.83	1.27	2.24	2.08	2.34	2.40	.....
29	3.33	1.73	1.18	1.75	2.02	2.09	5.43	.....
30	3.76	1.83	.98	1.56	1.95	2.01	4.48	.....
31	.....	1.72	.....	1.46	2.32	.....	4.12	.....

a Closed for winter November 24.

Miscellaneous discharge measurements of streams in Nebraska.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
June 22	Ash Creek, East	Bridge ¼ mile above forks.	T. J. O'Keefe	0.2
June 22	Ash Creek, West	do	do	.1
August 20	Ash Creek, East	do	do	.0
Do	Ash Creek, West	do	do	.0
July 17	Ash Creek, East	Head of Tomlin ditch, sec. 31, T. 32 N., R. 50 W.	A. B. McCoskey	.4
Do	Ash Creek, West	Above Broadhurst dam, sec. 35, T. 32 N., R. 51 W.	do	1.0
August 8	Beaver Creek	Above mill at Genoa	O. V. P. Stout	50.2
Do	do	Below diversion for Great East canal.	do	7.2
August 23	Little Blue River	Ayr	do	1.7
Do	do	W. of west line sec. 18, T. 5 N., R. 10 W.	do	1.6
June 7	Big Blue River	Blue Springs	do	262.0
Do	do	Wilber	do	189.8
Do	do	Dewitt	do	235.0
July 26	Blue Creek	Below head of Graff ditch, sec. 19, T. 16 N., R. 42 W.	E. D. Johnson	14.1
November 22	Buffalo Creek	Sec. 7, T. 1 N., R. 40 W	W. A. Channel	9.9
October 2	Deadman Creek	Head of Phillip's ditch, sec. 18, T. 30 N., R. 52 W.	T. J. O'Keefe	1.8
Do	do	Head of Porter and Rasmussen dams, sec. 1, T. 30 N., R. 53 W.	do	1.1
May 27	North Fork of Elkhorn River.	Norfolk Junction bridge	O. V. P. Stout	75.9
August 3	do	do	do	89.0
June 29	Frenchman River	Two miles above Culbertson.	Adna Dobson	79.0
August 17	do	Culbertson	O. V. P. Stout	84.0
July 26	do	Head Maranville dam, sec. 17, T. 6 N., R. 40 W.	A. B. McCoskey	a 3.4
Do	do	Head of Inman's dam, sec. 12, T. 6 N., R. 41 W.	do	a 8.0
Do	do	Head of Wirsig dam, sec. 24, T. 6 N., R. 40 W.	do	a 14.0
July 27	do	Wauneta	do	74.3
Do	do	Palisade	do	91.2

Miscellaneous discharge measurements of streams in Nebraska—Continued.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
September 29	Frenchman River	Head of Inman's ditch, sec. 17, T. 6 N., R. 40 W.	E. D. Johnson	6.2
July 26	Graff ditch	Near head	do	13.3
November 22	Horse Creek	Sec. 11, T. 1 N., R. 39 W	W. A. Channel	1.2
November 14	Indian Creek	Line between secs. 10 and 11, T. 2 N., R. 37 W.	do	1.3
May 17	Lodgepole Creek	Sec. 14, T. 14 N., R. 51 W	E. D. Johnson	2.3
May 18	do	Sec. 31, T. 14 N., R. 47 W	do	2.6
May 15	do	Sec. 33, T. 14 N., R. 49 W	do	3.9
Do	do	Sec. 34, T. 14 N., R. 49 W	do	6.3
May 22	do	Sec. 12, T. 12 N., R. 45 W	do	1.3
May 25	do	Sec. 36, T. 15 N., R. 57 W	do	4.7
May 23	do	Sec. 23, T. 23 N., R. 15 W	do	7.3
May 26	do	Sec. 2, T. 14 N., R. 58 W	do	9.2
May 21	do	Sec. 3, T. 13 N., R. 46 W	do	2.3
August 7	do	Sec. 36, T. 13 N., R. 45 W	do	3.1
August 8	do	Sec. 3, T. 14 N., R. 58 W	do	6.2
August 9	do	Sec. 23, T. 15 N., R. 55 W	do	6.3
August 10	do	Sec. 33, T. 15 N., R. 57 W	do	12.3
Do	do	Sec. 3, T. 12 N., R. 45 W	do	1.3
August 14	do	Sec. 33, T. 14 N., R. 49 W	do	6.4
August 16	do	Sec. 31, T. 14 N., R. 47 W	do	2.5
August 17	do	Sec. 14, T. 14 N., R. 51 W	do	2.3
August 22	do	Sec. 2, T. 13 N., R. 46 W	do	2.8
September 10	do	Above Polly ditch, sec. 30, T. 15 N., R. 55 W.	do	2.4
Do	do	Below Polly ditch, at bridge.	do	1.1
Do	do	One mile west of Kimball	do	1.3
September 12	do	Kimball	do	4.9
September 15	do	do	do	1.1
September 18	do	do	do	4.3
October 3	do	Above Neuman's dam	do	3.3
October 8	do	Lodgepole Station	do	2.1
October 18	do	Chappell	do	3.1
June 28	Medicine Creek	Cambridge	Adna Dobson	24.5
September 24	Monroe Creek	Sec. 33, T. 33 N., R. 56 W	T. J. O'Keefe	.1
June 28	Muddy Creek	Three miles above Arapahoe.	Adna Dobson	3.7
September 6	Niobrara River	Sec. 11, T. 28 N., R. 53 W	T. J. O'Keefe	10.8
September 7	do	Greggs's bridge, near Marsland.	do	11.2
July 18	do	Above Marsland, sec. 6, T. 28 N., R. 51 W.	A. B. McCoskey	7.0
August 7	do	Dunlap	do	14.1
Do	do	Head of Mirage canal, sec. 26, T. 29 N., R. 41 W.	do	*a* 14.5
Do	do	Sec. 29, T. 29 N., R. 47 W	do	4.0
August 13	Platte River	Fremont	O. V. P. Stout	2,300.0
December 20	South Platte River	North Platte	Adna Dobson	963.0
September 26	North Platte River	Gering bridge	A. B. McCoskey	333.1
November 5	do	do	do	624.8
October 26	Plain Creek	Hoef's mill, sec 27, T. 31 N., R. 34 W.	do	28.8
August 18	North Fork of Republican River.	Benkelman	O. V. P. Stout	41.7
Do	South Fork of Republican River.	do	do	3.0
September 29	Republican River	Culbertson	do	0.0
June 28	do	Cambridge	Adna Dobson	72.0
July 18	do	Bridge at Edison	E. D. Johnson	15.6
Do	do	Bridge at Oxford	do	14.3
July 27	do	Bridge at McCook	A. B. McCoskey	103.8
November 22	Rock Creek	Sec. 21, T. 1 N., R. 39 W	W. A. Channel	8.8
August 17	Salt Creek	Lincoln	Adna Dobson	5,807.0
August 22	Soldier Creek	Fort Robinson	T. J. O'Keefe	1.8
September 22	do	do	do	2.5
September 24	Sowbelly Creek	Head of Nutto ditch, sec. 24, T. 32 N., R. 56 W.	do	3.1
August 24	Turkey Creek	Naponee	O. V. P. Stout	7.0
September 25	Warbonnet Creek	Sec. 21, T. 33 N., R. 56 W	T. J. O'Keefe	.7
August 23	White Clay Creek	Sec. 1, T. 31 N., R. 52 W	do	1.5
September 1	White River	First wagon bridge below Crawford.	do	13.5
September 3	do	Whitney	do	5.0
August 22	do	Head of Crawford canal ditch.	do	14.0
July 16	do	Head of Crawford ditch	A. B. McCoskey	15.5
Do	do	Below Crawford	do	28.3

a Diverting all the water of the river at that point at the time the gaging was made.

REPUBLICAN RIVER NEAR SUPERIOR, NEBRASKA.

This station, which was established June 20, 1896, is located about 1 mile west of Superior. Discharge measurements are made from the highway bridge, thus determining the total amount of water passing over the dam and through the mill race. The discharge of the mill race is measured also, and is deducted from the total discharge, in order to determine the amount passing over the dam. The station is described in Water-Supply Paper No. 37, page 245. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 220. During 1900 the following measurements were made by O. V. P. Stout and Adna Dobson:

Discharge measurements of Republican River and mill race near Superior, Nebraska.

River.			Mill race.		
Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 15	0.91	989	April 15	.....	0
April 26	1.06	1,056	April 26	1.14	79
May 19	.63	457	May 19	2.60	113
June 1	.54	374	June 1	3.20	93
June 21	.43	312	June 21	3.10	58
August 16	1.73	433			
September 30	1.21	67			
October 23	1.31	118			

Daily gage height, in feet, of Republican River near Superior, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	0.74	0.94	0.73	0.41	1.14	(a)	0.94	0.83
2	.73	.92	.52	.39	1.35	(a)	.82	.98
3	.65	.90	.52	.30	—.25	(a)	.65	1.09
4	.65	.89	.49	.18	—.42	(a)	.99	1.23
5	.65	.84	.49	.21	1.29	(a)	.15	1.10
6	.64	.97	.48	.20	1.22	(a)	.15	1.12
7	.64	1.13	.43	.09	—.67	(a)	.01	1.15
8	.67	2.11	.39	.21	.01	(a)	.39	1.11
9	.62	1.61	.35	.09	—.08	(a)	.44	1.31
10	.64	1.25	.25	.39	—1.50	(a)	(a)	1.35
11	.64	1.10	.53	.24	(a)	1.72	.03	1.29
12	.68	1.02	.73	.19	(a)	2.62	.....	1.31
13	.80	.92	.79	.07	(a)	1.67	.22	1.30
14	.75	.90	.58	—.50	(a)	1.40	(a)	1.21
15	.91	.82	.51	—.58	.21	1.30	.41	1.24
16	1.00	.77	.65	.51	2.25	1.32	.25	1.29
17	1.10	.74	.41	.73	1.52	1.16	(a)	1.20
18	1.04	.66	.42	.90	1.40	1.22	.13	1.32
19	.98	.63	.42	1.05	1.42	1.19	.28	1.22
20	.98	.59	.41	1.23	1.24	1.17	.07	1.25
21	1.20	.62	.43	1.20	1.23	1.13	1.37	(b)
22	1.09	.62	.52	1.22	1.20	1.05	1.28	(b)
23	1.00	.59	.57	1.14	1.20	1.21	1.31	1.20
24	1.41	.63	.41	1.21	1.15	1.02	1.26	c 1.32
25	1.01	.70	.53	1.14	1.03	.82	1.22	.....
26	1.06	.63	.53	1.18	.91	(a)	1.30	.....
27	1.11	.59	.54	1.09	.90	.23	1.15	.....
28	1.17	.49	.50	.72	.99	.32	1.25	.....
29	1.13	.49	.43	1.63	.10	.39	1.12	.....
30	1.00	.58	.38	1.46	(a)	.83	1.06	.....
31	.....	.49		1.30	(a)	.....	.87	.....

a No water at gage; all in mill race. b Ice. c Closed for the winter November 24.

Daily center depth, in feet, of mill race near Superior, Nebraska, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.65	3.60	4.53	4.28	5.00	2.00	3.41	3.50
2	3.59	3.75	3.85	4.30	5.35	.65	3.22	3.53
3	3.78	3.89	4.04	4.33	2.50	.54	3.14	3.53
4	3.60	3.84	4.12	4.27	2.25	.52	3.27	3.60
5	3.57	3.54	4.12	4.15	5.21	.53	2.60	3.60
6	3.59	3.57	4.11	4.04	5.09	.53	2.71	3.61
7	3.70	4.00	4.11	3.62	3.29	.50	2.53	3.66
8	3.97	4.31	4.10	4.07	3.85	.45	2.88	3.59
9	3.59	4.21	4.02	3.94	3.53	.40	2.95	3.88
10	3.89	2.99	3.70	4.28	1.33	.53	2.55	3.75
11	3.87	2.70	4.27	3.93	1.00	3.25	2.68	3.83
12	3.82	2.76	4.47	3.90	1.11	6.55	2.63	3.70
13	3.99	1.47	4.00	3.87	1.05	4.23	2.82	3.75
14	3.76	1.52	4.00	3.36	1.12	4.82	2.20	3.69
15	3.00	1.33	3.83	3.06	3.93	4.52	3.12	3.97
16	4.20	1.53	4.39	4.48	5.25	3.93	3.02	3.80
17	4.27	2.00	4.30	4.58	5.15	3.62	2.63	3.82
18	3.18	2.87	4.32	4.76	5.00	3.52	2.83	3.82
19	3.08	2.60	4.30	4.90	4.98	3.57	2.86	3.72
20	2.89	3.02	4.06	5.13	5.00	3.57	2.63	3.69
21	3.37	3.57	3.10	5.10	4.85	3.52	3.99	3.30
22	3.15	3.59	3.40	5.11	4.58	3.48	3.92	3.68
23	3.00	3.80	3.38	5.00	4.82	3.58	3.99	3.50
24	3.89	3.95	3.90	5.02	4.87	3.52	3.92	3.95
25	2.29	3.85	4.20	5.12	4.72	3.32	3.95	.....
26	2.80	4.02	4.34	4.92	4.52	2.52	3.89	.....
27	2.78	2.63	4.54	4.90	4.68	2.80	3.78	.....
28	3.20	4.02	4.40	4.60	4.55	2.80	4.02	.....
29	3.30	3.58	4.38	5.27	3.65	3.00	3.80	.....
30	3.60	4.33	4.12	5.40	3.12	3.14	3.62	.....
31	.....	4.05	.....	5.00	3.22	.....	3.55	.....

REPUBLICAN RIVER AT JUNCTION, KANSAS.

This station is described in Water-Supply Paper No. 37, page 248. On October 23, 1900, a new bench mark was established, at an elevation of 12.35 feet above the zero of the old gage. It is a spike driven in the west side of a cottonwood tree 18 inches in diameter and 10 feet west of the bridge. The spike is about 2 feet above the ground. The observer is W. M. Hickman, engineer of the waterworks pumping station, which is about 100 feet from the gage. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 221. During 1900 the following measurements were made:

May 5: Gage height, 4.50 feet; discharge, 1,158 second-feet.
May 22: Gage height, 4.10 feet; discharge, 851 second-feet.
September 24: Gage height, 3.40 feet; discharge 364 second-feet.
October 23: Gage height, 2.80 feet; discharge, 203 second-feet.
November 30: Gage height, 2.80 feet; discharge, 183 second-feet.

Daily gage height, in feet, of Republican River at Junction, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.7	3.8	4.2	5.2	3.8	3.5	3.4	3.0	3.3	3.0	2.8
2	3.5	3.9	4.0	4.0	5.0	3.8	3.5	3.3	3.0	3.3	2.8	2.8
3	3.8	3.9	4.0	4.0	4.6	3.9	3.4	3.3	3.0	3.3	2.8	2.8
4	3.6	3.9	4.2	3.9	4.6	3.7	3.3	3.0	3.2	3.3	2.7	2.9
5	3.5	4.0	3.9	3.8	4.5	3.7	3.3	3.0	3.1	3.2	2.7	2.9
6	3.8	4.1	4.2	3.8	4.4	3.9	3.3	3.2	3.0	3.2	2.7	3.1
7	3.6	4.2	4.2	3.8	4.0	3.8	3.3	3.2	2.9	3.2	2.7	3.1
8	3.4	4.2	4.6	3.8	4.5	3.7	3.3	3.3	3.0	3.3	2.6	3.0
9	3.6	4.1	6.8	4.0	4.7	3.7	3.2	3.4	3.0	3.3	2.6	2.9
10	3.6	3.9	6.4	3.9	4.9	3.7	3.1	3.3	2.9	3.3	2.6	2.9
11	3.8	4.1	6.2	3.9	5.1	3.6	3.1	3.0	3.0	3.2	2.7	2.9
12	3.6	4.2	5.4	3.8	6.1	3.6	3.1	3.0	3.0	3.2	2.7	3.0
13	3.6	3.8	5.2	3.8	6.0	4.0	3.0	3.0	3.3	3.1	2.7	3.0
14	3.5	3.9	4.4	3.7	5.3	3.7	3.0	3.1	5.5	3.0	2.7	3.1
15	3.7	4.1	4.5	3.6	4.5	3.7	3.2	3.0	6.0	3.0	2.7	3.1
16	3.7	3.8	4.6	4.5	4.7	3.6	3.2	2.9	5.9	3.0	2.8	3.0
17	3.7	3.8	4.9	4.9	4.7	3.6	3.3	2.7	4.9	3.0	2.7	3.0
18	3.6	3.8	4.6	6.0	4.9	4.3	3.4	2.7	4.7	2.9	2.8	3.0
19	3.8	3.8	4.4	6.2	4.9	3.7	3.3	2.7	4.0	2.9	2.8	3.0
20	3.8	3.9	4.5	5.9	4.7	3.7	3.3	2.7	3.6	2.9	2.8	3.0
21	3.8	3.9	4.2	5.2	4.5	3.6	3.3	2.7	3.5	3.1	2.8	3.1
22	3.9	4.0	4.2	5.4	4.3	3.6	3.3	3.0	3.5	3.4	2.7	3.3
23	3.7	4.1	4.2	5.4	4.2	3.5	3.5	3.0	3.5	2.8	2.9	3.3
24	3.9	4.2	4.0	5.0	4.1	3.6	3.5	3.5	3.4	2.8	2.9	3.2
25	3.8	4.0	4.3	5.2	4.0	3.7	3.4	3.3	3.3	2.8	2.8	3.2
26	3.8	4.0	4.4	5.4	4.0	3.6	4.0	3.3	3.4	2.7	2.8	3.1
27	3.9	3.8	4.2	5.7	4.0	3.5	3.7	3.3	5.9	2.7	2.7	3.2
28	3.8	3.8	4.0	5.9	4.1	3.5	3.5	3.2	4.3	2.7	2.7	3.2
29	3.9	.....	4.0	5.5	4.0	3.5	3.5	3.2	3.8	2.8	2.8	3.2
30	3.8	.....	4.0	5.0	4.5	3.5	3.4	3.3	3.5	3.0	2.8	.....
31	3.7	.....	4.2	.....	4.6	.....	3.4	3.2	.....	3.2	.....	.....

SOLOMON RIVER NEAR NILES, KANSAS.

This station is described in Water-Supply Paper No. 37, page 249. Records of discharge measurements will be found as follows: For 1897, Nineteenth Annual Report, Part IV, page 342; for 1898, Twentieth Annual Report, Part IV, page 214; for 1899, Twenty-first Annual Report, Part IV, page 223. During 1900 the following discharge measurements were made by W. G. Russell:

Discharge measurements of Solomon River near Niles, Kansas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 20	18.05	3,698	October 4	4.60	75
April 21	12.10	1,636	October 30	4.60	63
May 23	6.00	266	December 1	4.90	82
June 14	5.40	157			

Daily gage height, in feet, of Solomon River near Niles, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.9	4.7	5.5	5.0	7.8	5.9	5.0	6.9	4.5	4.7	4.6	4.6
2	5.0	5.0	5.2	4.9	7.3	6.2	5.2	6.3	4.6	4.7	4.5	4.9
3	5.0	4.8	5.1	4.8	6.9	7.0	5.1	5.1	4.5	4.8	4.6	4.8
4	5.0	4.9	5.1	5.0	6.9	7.8	4.9	5.8	4.5	4.7	4.7	5.0
5	5.0	5.0	5.2	5.0	6.4	9.0	4.8	5.6	4.5	4.6	4.7	4.6
6	5.0	4.7	5.2	4.9	6.4	7.7	4.7	5.3	4.4	8.5	4.4	4.8
7	4.9	4.9	5.6	5.0	6.2	7.0	4.7	5.3	4.4	7.3	4.5	4.6
8	4.9	4.7	5.8	5.0	6.1	6.8	4.6	5.4	4.5	5.6	4.7	4.3
9	4.6	5.0	6.3	4.9	6.5	5.7	4.6	5.1	4.2	5.0	4.8	4.7
10	4.6	5.1	12.9	4.8	9.5	5.5	4.5	5.1	4.3	4.9	4.3	4.6
11	4.8	5.2	9.6	4.8	7.8	5.4	4.5	4.9	4.5	4.9	4.6	4.7
12	4.8	5.1	7.2	4.9	8.6	5.4	4.4	9.0	4.4	4.8	4.7	5.0
13	5.0	5.0	6.5	4.9	7.3	5.4	4.4	7.4	4.4	4.9	4.8	4.3
14	4.9	5.0	6.2	4.7	7.1	5.4	5.1	7.0	4.3	4.6	4.3	4.7
15	4.8	4.9	5.7	5.1	6.5	5.3	4.8	5.5	5.5	4.6	4.2	4.8
16	4.7	5.0	5.6	5.2	10.3	5.4	4.4	5.1	13.4	4.6	4.6	4.7
17	4.6	5.0	5.3	6.2	9.0	5.5	4.3	5.1	8.1	4.5	4.6	4.5
18	4.3	5.0	5.3	18.3	8.4	5.4	4.3	5.0	7.0	4.5	4.6	4.4
19	4.7	5.0	5.3	20.2	7.5	5.3	4.6	7.8	6.5	4.8	4.5	4.4
20	4.8	5.0	5.2	20.1	6.8	5.2	4.4	8.9	6.0	4.8	4.5	4.5
21	5.1	5.4	5.2	12.4	6.5	5.1	4.3	7.0	7.9	4.7	4.8	4.6
22	5.2	5.3	5.1	8.8	6.3	5.1	4.3	6.2	6.0	4.8	4.5	4.8
23	5.1	5.4	5.2	8.4	5.9	5.0	4.2	5.3	5.5	4.8	4.9	4.5
24	5.1	5.0	5.0	7.6	5.8	4.9	7.9	5.3	5.2	4.7	5.0	4.6
25	5.0	5.1	4.8	7.2	5.7	5.0	5.5	5.3	5.0	4.6	4.6	4.7
26	4.9	5.0	4.9	7.1	9.7	4.9	4.7	5.0	10.3	4.8	4.7	4.4
27	4.8	5.0	4.9	7.8	9.5	4.8	5.4	4.9	9.0	4.6	4.4	4.7
28	4.8	4.9	4.9	8.8	9.8	4.9	5.1	4.8	6.8	4.5	4.4	4.9
29	5.0	------	5.0	9.7	7.1	4.9	5.2	4.6	5.4	4.7	4.6	4.6
30	5.1	------	5.0	8.3	6.4	5.0	7.5	4.6	5.0	4.6	4.7	------
31	4.7	------	4.9	------	6.0	------	7.9	4.5	------	4.7	------	------

SALINE RIVER NEAR SALINA, KANSAS.

This station is described in Water-Supply Paper No. 37, page 250. The observer is Charles Tressin. Records of results of measurements will be found as follows: For 1897, Nineteenth Annual Report, Part IV, page 346; for 1898, Twentieth Annual Report, Part IV, page 316; for 1899, Twenty-first Annual Report, Part IV, page 224. During 1900 the following discharge measurements were made by W. G. Russell:

April 7: Gage height, 3.70 feet; discharge, 57 second-feet.
April 21: Gage height, 19.00 feet; discharge, 2,851 second-feet.
May 23: Gage height, 5.90 feet; discharge, 197 second-feet.
October 4: Gage height, 5.00 feet; discharge, 133 second-feet.
October 30: Gage height, 3.90 feet; discharge 55 second-feet.
December 2: Gage height, 3.90 feet; discharge, 52 second-feet.

Daily gage height, in feet, of Saline River near Salina, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.9	3.5	4.0	3.9	6.1	5.9	4.3	5.0	4.1	4.1	4.3	3.9
2	3.8	3.4	3.9	3.8	6.2	6.9	4.9	5.0	3.7	3.9	4.0	3.9
3	3.7	3.4	3.4	3.8	6.5	12.0	5.4	4.8	3.5	3.7	3.9	3.9
4	3.7	3.5	4.2	3.8	6.8	14.1	4.7	4.5	3.6	5.0	3.7	3.9
5	3.5	3.4	4.2	3.7	6.4	9.2	4.4	4.5	3.4	4.5	3.7	3.9
6	3.6	3.3	3.9	3.8	6.1	6.8	4.2	4.4	3.4	3.9	3.8	3.9
7	3.5	3.4	4.1	3.8	5.8	6.1	4.0	4.3	3.3	3.8	3.7	3.9
8	3.6	3.5	4.3	3.8	5.7	5.7	4.0	4.3	3.2	3.7	3.7	3.8
9	3.6	3.7	6.0	3.8	5.7	5.4	3.9	4.1	3.2	3.6	3.5	3.8
10	3.6	3.7	10.1	3.9	6.6	5.1	3.7	3.8	3.3	3.6	3.5	3.7
11	3.5	3.7	8.2	3.8	8.4	5.0	4.0	4.0	3.4	3.6	3.7	4.0
12	3.6	3.6	6.5	4.0	7.0	4.8	3.7	3.9	6.2	3.4	3.5	3.8
13	3.6	3.7	6.1	3.9	6.2	4.7	4.4	3.8	6.0	3.5	3.6	3.9
14	3.8	3.6	5.5	4.1	5.8	4.7	4.0	3.8	4.2	3.5	3.7	3.8
15	3.9	3.5	4.9	4.2	8.4	4.6	3.7	3.4	3.6	3.5	3.7	3.8
16	3.9	(a)	4.6	6.5	11.5	4.4	3.7	3.6	4.4	3.5	3.6	3.7
17	3.8	(a)	4.3	5.2	10.2	4.4	3.5	3.6	4.6	3.2	3.5	3.8
18	3.7	(a)	4.1	12.9	8.5	4.5	3.6	3.5	4.1	3.5	3.7	3.9
19	3.6	3.5	4.0	15.9	7.3	4.4	3.6	3.4	4.0	3.5	3.8	3.7
20	3.8	3.5	3.9	18.0	6.7	4.2	3.6	3.2	4.2	3.3	3.6	3.6
21	3.8	3.6	3.7	19.2	6.2	4.5	3.5	3.2	3.6	3.5	3.5	3.8
22	3.6	3.7	3.8	15.1	6.0	7.8	3.5	3.0	3.6	3.9	3.7	3.8
23	3.7	3.6	3.8	9.1	5.7	7.9	3.7	3.0	3.5	4.0	3.7	3.9
24	3.8	3.6	4.0	7.9	5.5	6.4	19.0	3.3	3.6	3.7	3.6	4.0
25	3.7	3.6	3.9	7.4	5.5	5.7	20.2	3.2	3.5	4.9	3.9	3.9
26	3.7	3.7	3.9	7.7	12.5	5.3	17.5	3.4	12.8	3.5	4.0	3.8
27	3.3	3.7	3.8	7.0	11.8	5.0	11.8	3.2	8.0	4.0	3.8	3.8
28	3.5	3.9	3.7	6.9	7.1	4.8	7.1	3.3	5.4	3.8	3.7	3.6
29	3.5	.....	3.8	6.6	6.2	4.8	5.7	4.9	4.8	3.8	3.7	3.9
30	3.6	.....	3.7	6.2	7.0	4.5	5.5	7.6	4.5	3.8	3.9	.....
31	3.6	.....	3.7	.....	6.1	.....	5.1	5.2	.....	3.7	.....	.....

a Frozen.

SMOKY HILL RIVER AT ELLSWORTH, KANSAS.

This station is described in Water-Supply Paper No. 37, page 251. On October 22, 1900, the bench mark was tested and found to be correct. This river has not fluctuated much during the year. There were a few periods of high water, but they were of short duration, and the river quickly resumed its normal stage. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 225. During 1900 the following measurements were made by W. G. Russell:

April 9: Gage height, 1.05 feet; discharge, 22 second-feet.
June 19: Gage height, 1.70 feet; discharge, 136 second-feet.
September 14: Gage height, 2.42 feet; discharge, 416 second-feet.
October 22: Gage height, 1.20 feet; discharge, 57 second-feet.

Daily gage height, in feet, of Smoky Hill River at Ellsworth, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	1.10	(a)	1.05	1.85	2.40	1.90	1.50	1.00	1.55	1.10	0.90
2	(a)	1.10	(a)	1.05	1.85	2.40	3.10	1.50	.95	1.50	1.10	.85
3	(a)	1.10	(a)	1.10	1.80	2.20	2.30	1.45	.90	1.50	1.10	.85
4	(a)	(a)	1.30	1.10	1.70	2.00	2.10	1.40	.90	1.50	1.10	.85
5	1.25	(a)	(a)	1.05	1.70	1.60	1.80	1.40	.85	1.50	1.10	.90
6	1.25	1.50	(a)	1.05	1.65	1.55	1.60	1.35	.85	1.70	1.05	.90
7	1.20	1.50	(a)	1.05	1.65	1.55	1.55	1.30	.85	1.60	1.05	.85
8	1.20	(a)	1.40	1.05	1.60	1.50	1.50	1.30	.85	1.60	1.05	.85
9	1.25	(a)	1.75	1.05	1.60	1.50	1.50	1.25	.95	1.55	1.00	.85
10	1.20	(a)	1.85	1.05	1.60	1.50	1.40	1.20	1.00	1.55	1.00	.85
11	1.20	(a)	1.45	1.10	1.55	1.55	1.40	1.20	1.30	1.50	1.00	.85
12	1.20	(a)	1.40	1.20	1.50	1.55	1.35	1.15	1.50	1.50	.95	.85
13	1.15	(a)	1.35	1.25	1.50	1.50	1.30	1.10	1.30	1.45	.95	.85
14	1.15	(a)	1.30	1.35	1.50	1.50	1.30	1.05	1.70	1.40	.95	.90
15	1.20	(a)	1.30	1.45	1.75	1.50	1.25	1.00	2.60	1.40	.90	.90
16	1.20	(a)	1.30	1.50	1.80	1.45	1.25	1.00	2.90	1.35	.90	.90
17	1.15	(a)	1.25	1.90	1.70	1.50	1.20	1.00	2.40	1.30	.90	.90
18	1.10	(a)	1.25	1.80	1.70	1.65	1.15	.95	2.00	1.30	.90	.90
19	1.10	(a)	1.20	2.85	1.65	1.70	1.10	.95	2.00	1.25	.90	.90
20	1.15	(a)	1.20	2.60	1.60	1.90	1.30	.95	1.90	1.20	.90	.90
21	1.15	(a)	1.20	2.45	1.50	2.90	1.10	.90	1.90	1.30	.90	.90
22	1.10	(a)	1.15	2.40	1.50	2.80	1.10	.90	1.85	1.40	.95	.95
23	1.10	1.15	1.15	2.20	1.45	2.75	1.05	.90	1.80	1.30	.95	.95
24	1.10	(a)	1.10	2.10	1.45	2.70	1.70	.85	1.70	1.25	.95	.95
25	1.50	(a)	1.10	2.00	1.40	2.60	1.40	1.20	1.60	1.20	.90	.90
26	1.10	(a)	1.10	1.90	3.00	2.40	1.30	1.20	1.70	1.20	.90	.90
27	1.10	(a)	1.15	1.80	2.00	2.20	1.35	1.20	1.70	1.15	.90	.90
28	1.10	(a)	1.15	1.75	1.80	2.00	1.25	1.15	1.65	1.15	.90	.90
29	(a)	.....	1.10	1.80	1.60	1.90	1.40	1.10	1.60	1.15	.90	.90
30	(a)	.....	1.10	1.75	1.60	2.00	1.60	1.05	1.55	1.10	.90	.....
31	(a)	.....	1.50	.....	1.50	.....	1.55	1.05	.....	1.10	.....	.....

a Frozen.

BLUE RIVER NEAR MANHATTAN, KANSAS.

This station is described in Water-Supply Paper No. 37, page 252. On December 17, 1900, the gage wire and weight were stolen, and a new gage was established at the same elevation as the old gage. Since September 18, 1900, Elmer Drake has been the observer at this station, his home being about 40 yards from the gage. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 227. During 1900 the following measurements were made:

Discharge measurements of Blue River near Manhattan, Kansas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 4	6.10	1,518	September 25	5.75	1,342
May 22	6.00	1,389	October 24	4.40	711
June 14	4.60	702	November 24	4.30	570
June 25	4.50	723			

Daily gage height, in feet, of Blue River near Manhattan, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	4.05	4.95	4.30	7.55	5.60	6.15	4.75	6.70	4.90	5.40	4.25
2	4.60	3.95	4.90	4.40	6.90	5.90	4.70	4.95	5.70	5.20	6.00	4.20
3	4.35	4.20	4.80	4.25	6.30	6.10	4.10	4.65	5.15	5.05	5.60	4.20
4	4.35	4.05	4.65	4.05	6.10	5.60	4.05	4.50	4.80	4.70	5.05	4.15
5	4.55	4.05	5.20	4.15	5.65	5.15	4.05	4.35	4.40	5.30	4.75	4.10
6	4.35	4.15	6.15	4.15	5.65	5.00	3.95	4.15	4.15	5.15	4.45	4.20
7	4.25	4.05	7.25	4.20	7.90	4.85	3.85	4.10	4.30	4.95	4.40	4.30
8	4.20	3.70	10.85	4.25	13.00	4.90	3.85	4.00	4.15	4.60	4.40	4.30
9	4.25	3.90	10.80	4.15	12.85	4.75	3.80	4.10	4.15	4.45	4.40	4.30
10	4.25	4.20	8.10	4.20	10.95	4.65	3.75	4.00	4.05	4.35	4.40	4.30
11	4.15	4.25	7.25	4.20	9.55	4.55	3.85	4.00	4.05	4.30	4.40	4.30
12	4.25	4.10	6.60	4.10	8.75	4.45	5.10	4.00	4.20	4.25	4.30	4.20
13	4.35	4.05	5.95	4.05	8.10	4.60	4.60	4.30	4.20	4.20	4.30	4.20
14	4.35	4.25	5.60	4.05	7.25	4.50	4.15	4.35	4.85	4.20	4.30	4.30
15	4.35	4.15	5.25	4.15	7.10	5.75	3.95	4.15	9.55	4.20	4.30	4.20
16	4.25	4.35	5.10	5.50	10.60	5.15	10.00	4.65	8.70	4.20	4.30	4.20
17	4.35	4.05	4.95	5.30	11.10	4.95	20.00	4.85	8.55	4.20	4.30	4.20
18	4.35	4.15	4.75	6.20	8.65	4.85	13.80	4.60	8.00	4.20	4.30	4.20
19	4.25	4.00	4.65	7.10	6.95	6.15	10.00	5.65	7.30	4.15	4.30	4.20
20	4.15	4.05	4.65	6.95	6.50	5.50	9.15	6.30	7.85	4.10	4.30	4.20
21	4.25	4.25	4.55	6.30	6.20	4.80	8.75	5.95	8.10	4.20	4.30	4.20
22	4.25	4.30	4.60	6.05	5.95	4.80	7.90	5.75	7.40	4.40	4.30	4.20
23	4.15	4.15	4.45	5.50	5.75	4.70	7.25	5.45	6.65	4.40	4.20	4.20
24	4.25	4.35	4.40	5.55	5.50	4.55	9.95	5.15	6.30	4.40	4.30	4.25
25	4.25	4.55	4.35	6.70	5.50	4.30	7.95	5.35	5.70	4.40	4.30	4.30
26	4.15	4.70	4.40	7.95	5.45	4.35	6.70	5.30	9.30	4.40	4.20	4.25
27	4.15	4.65	4.35	9.65	5.95	4.20	6.20	5.10	9.60	4.40	4.25	4.20
28	3.40	4.60	4.40	8.60	5.80	4.20	5.35	4.75	6.95	4.45	4.30	4.10
29	4.25	.....	4.35	7.20	6.15	4.30	5.35	5.75	5.70	4.60	4.30	4.10
30	4.10	.....	4.50	9.05	5.40	6.30	5.05	6.55	5.05	4.70	4.30	.....
31	3.95	.....	4.45	.....	5.45	.....	4.70	7.95	.....	4.70	.....	.....

KANSAS RIVER AT LECOMPTON, KANSAS.

This station is described in Water-Supply Paper No. 37, page 253. On June 24, 1900, a new gage was established, the old gage having been broken. The present gage, a pine board 1 inch by 1 inch by 10 feet long, divided into feet and tenths, is spiked on top of the old gage, and is at the same elevation. On October 26, 1900, a bench mark was established on top of the bottom flange of the iron strut connecting the two iron cylinders at the south end of the highway bridge over the river. The bench mark is at the west end of the strut, next to the cylinder. Its elevation is 12.19 feet above the zero of the gage. Records of discharge during 1899 will be found in Twenty-first Annual Report, Part IV, page 228. During 1900 the following discharge measurements were made by W. G. Russell:

Discharge measurements of Kansas River at Lecompton, Kansas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 19	6.20	12,352	October 3	4.70	6,080
May 21	4.95	7,669	October 26	3.00	3,441
June 13	3.30	4,455	November 26	2.90	4,436
June 24	3.10	4,333			

Daily gage height, in feet, of Kansas River at Lecompton, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	2.20	2.50	3.60	5.00	5.60	4.75	3.90	3.75	5.15	4.20	2.80
2	2.40	2.20	2.60	3.60	5.60	5.35	4.70	3.65	4.00	4.60	5.25	2.80
3	2.30	2.20	2.70	3.60	5.35	5.10	4.40	3.40	3.95	4.75	4.65	2.80
4	2.30	2.30	2.85	3.50	4.95	4.75	4.20	3.05	3.90	4.70	4.30	2.80
5	2.30	2.40	3.10	3.50	4.80	4.55	3.90	3.00	3.85	4.45	4.20	2.70
6	2.30	2.45	3.70	3.40	4.55	4.35	3.55	3.00	3.80	4.40	4.20	2.70
7	2.30	2.55	4.95	3.40	4.50	4.15	3.35	3.00	3.70	4.20	4.15	2.70
8	2.40	2.60	7.35	3.60	4.45	4.00	3.25	2.90	3.45	4.15	4.05	2.70
9	2.50	2.60	9.90	3.60	5.10	4.00	3.15	2.90	3.25	4.10	4.00	2.70
10	2.50	2.60	10.20	3.60	6.50	3.85	3.00	2.80	3.20	4.00	3.80	2.70
11	2.60	2.70	8.40	3.50	5.85	3.65	2.90	2.80	3.20	4.00	4.05	2.70
12	2.60	2.70	7.25	3.50	5.45	3.45	2.80	2.70	3.20	3.85	4.00	2.70
13	2.60	2.80	6.35	3.40	5.35	3.30	2.80	2.70	3.10	3.70	3.80	2.60
14	2.70	2.80	5.90	3.40	5.20	3.30	2.95	2.70	3.00	3.60	3.75	2.60
15	2.70	2.70	5.45	3.20	5.00	3.25	2.90	2.95	3.15	3.60	3.60	2.60
16	2.60	2.70	4.90	3.30	5.00	3.20	2.90	3.35	3.25	3.55	3.50	2.60
17	2.60	2.65	4.50	3.30	5.10	3.20	3.05	3.45	5.80	3.50	3.35	2.60
18	2.60	2.60	4.50	3.65	6.35	3.20	8.40	3.30	5.70	3.50	3.40	2.60
19	2.50	2.60	4.25	4.50	6.00	3.20	7.90	3.10	5.55	3.40	3.40	2.60
20	2.50	2.50	4.05	4.70	5.20	3.20	5.75	3.05	5.45	3.30	3.40	2.60
21	2.50	2.50	4.00	4.90	4.95	3.20	5.15	3.00	5.30	3.30	3.30	2.60
22	2.50	2.50	3.90	5.60	4.80	3.10	5.00	3.15	5.10	3.20	3.25	2.60
23	2.40	2.45	3.90	5.70	4.80	3.10	5.25	3.45	4.65	3.20	3.20	2.60
24	2.40	2.40	3.80	5.50	4.70	3.10	5.60	3.55	4.55	3.20	3.15	2.60
25	2.40	2.40	3.80	5.20	4.65	3.10	5.90	3.70	4.65	3.10	2.90	2.60
26	2.35	2.40	3.75	4.95	4.60	3.00	5.45	3.70	5.25	3.00	2.90	2.60
27	2.30	2.40	3.70	4.90	4.75	3.00	5.00	3.60	6.20	2.95	2.90	2.60
28	2.30	2.40	3.65	4.90	4.85	3.00	5.00	3.50	6.90	2.90	2.90	2.60
29	2.30	.....	3.60	5.70	5.20	4.05	4.85	3.45	7.50	2.90	2.85	2.60
30	2.30	.....	3.60	5.55	5.75	4.35	4.60	3.35	5.90	2.95	2.80	.....
31	2.30	.....	3.60	.....	5.90	.....	4.30	3.40	.....	3.50	.....	.....

ARKANSAS RIVER.

This river and its tributaries drain practically all of the southwestern quarter of the State of Colorado. The main stream heads in the vicinity of Tennessee Pass, in the central portion of the State. Thence it flows southerly for about 70 miles, then easterly for about 50 miles, to Canyon, receiving a number of tributaries from the mountainous area on either side. At Canyon it suddenly emerges from the main mountainous area, and thence it flows in an easterly direction through Pueblo, where it enters the great plains of eastern Colorado and Kansas. Within 200 miles of Canyon practically all of the water of the river is diverted for irrigation, even most of the flood waters being stored and used, so that little water, except at the very highest stages of the river, flows out of the State of Colorado. There is still, however, a considerable discharge during April and May, which was unusually large for those months of the year 1900, when, owing to the heavy rains upon the plains, the discharge of the stream was abnormal, and vast quantities of water flowed from it into the Gulf of Mexico.

The tributaries are of two classes: (1) Those that issue from the mountains, which have a perennial flow, and (2) those which drain the great plains, receiving water only during rains or in the early spring. Of the first class are Lake Creek, Badger Creek, and Grape Creek; while Fountain Creek, St. Charles River, Huerfano River, Apishapa River, and Purgatory River receive a portion of their supply from the plains and a portion from the mountains. Of the second

class are such water courses as Horse Creek, Adobe Creek, Big Sandy Creek, Timpas Creek, and many others of lesser note. The drainage from the plains is at times enormous, but usually the water courses of that district are dry. The flood discharge from some of these creeks has been estimated to be at least 10,000 cubic feet per second. Of the streams which head in the mountains but flow for long distances through the plains, the normal discharge is invariably used for irrigation, no water being discharged into the Arkansas except during flood seasons. Considerable water is being stored along the Arkansas, in the reservoirs of The Great Plains Water Company, also at Twin Lakes, while other reservoirs of importance but of smaller size are filled during the flood season. More water might, however, be stored by building canals large enough to receive that from the plains and conduct it to reservoirs.

A number of gaging stations have been maintained along the Arkansas and its tributaries, which will be described on the following pages in their geographic order. Those along the Lower Arkansas in Colorado were maintained with the assistance and cooperation of The Great Plains Water Company, one of the engineers of which, Mr. C. W. Beach, has made a number of measurements.

The seepage of the Arkansas Basin furnishes an interesting problem, which is being investigated by Prof. L. G. Carpenter, of the Colorado State Agricultural College, at Fort Collins. A study has also been made of the underground supply, the results of which have been published in the records of the United States Geological Survey.[1]

During the year 1900 about 30,000 acre-feet of water was stored in the reservoirs of The Great Plains Water Company, and the dam at the Twin Lakes reservoir was completed, permitting the use, during the latter part of the irrigation season, of these lakes, to the great benefit of crops lying under the canal of the Twin Lakes Land and Water Company.

LAKE CREEK AT TWIN LAKES, COLORADO.

This creek enters the Arkansas a short distance above Granite, Colorado. It is not a large stream, but it is of importance because it flows through Twin Lakes, which have been adapted as reservoirs by the Twin Lakes Land and Water Company. Measurements of this creek were begun June 21, 1899, by O. O. McReynolds, chief engineer of the Twin Lakes Land and Water Company, who at that time had charge of the work on the dam, and records were kept for a short time during that summer and again during the summer of 1900. In July, 1900, the stations were relocated and put upon a somewhat more permanent basis, one station being established July 10, at a point where the stream discharges from the upper lake, the gage rod being fastened to a fishway constructed several years before.

[1] Sixteenth Ann. Rept., Pt. II, pp. 535-588.

The measurements were made by wading. The channel at this upper station, known as the Interlaken station, is permanent and of such a character that excellent results were obtained, but the station can not be maintained in 1901, as the storage of water in the reservoirs will flood the locality to such an extent that it will be impossible to make measurements. The lower Twin Lakes station was established July 16, 1900, by O. O. McReynolds, at a footbridge constructed across the channel below the point where the artificial waterway from the lower lake enters the natural channel, the gage being fastened to one of the supports of the footbridge. The channel is rocky, but is fairly permanent in nature, the banks being high and not subject to overflow. The object of establishing the two stations was to ascertain the amount of storage water turned out from the lower lake by the water company, in order to determine the quantity of water the company would be entitled to at its head gate below. The records were kept by O. O. McReynolds.

In addition to the measurements made at the stations on Twin Lakes, one measurement was made at Granite, below the mouth of Lake Creek, namely, on July 9, when the discharge was found to be 570 second-feet. During 1900 no station was regularly maintained at Granite.

A description of the stations first established was published in Water-Supply Paper No. 37, page 256. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 238. During 1900 the following measurements were made by A. L. Fellows, O. O. McReynolds, and C. W. Beach:

Discharge measurements at Twin Lakes, Colorado.

New (Interlaken) station, at head of channel between lakes.			Old station at bridge between lakes.		
Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
July 10	0.85	248	July 9	1.70	203
July 18	.50	122	July 16	1.00	146
August 3	.25	52			
September 4	.15	25			

New station at junction of old channel and new cut below lower lake.			Old station at head of old channel below lower lake.		
Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
July 16	2.40	245	July 10	2.50	193
July 18	2.35	210			
Do	2.50	260			
Do	1.97	118			
August 11	2.13	156			
September 4	1.30	25			

Daily gage height, in feet, of Lake Creek at new (Interlaken) station between Twin Lakes, Colorado, for 1900.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1		0.30	0.20	12		0.23		23	0.45	0.20	
2		.30	.20	13		.20		24	.40	.20	
3		.30	.20	14		.20		25	.40	.20	
4		.30	.20	15		.20		26	.40	.20	
5		.30	.20	16		.20		27	.40	.20	
6		.30	.20	17		.20		28	.36	.20	
7		.30	.20	18		.20		29	.35	.20	
8		.30	.20	19		.20		30	.35	.20	
9		.25		20		.20		31	.33	.20	
10		.25		21		.20					
11		.25		22	0.45	.20					

Daily gage height, in feet, of Lake Creek at new station below lower of Twin Lakes, Colorado, for 1900.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1		1.60	1.40	12		2.14		23	2.40	2.10	
2		1.60	1.40	13		2.10		24	2.40	2.10	
3		1.60	1.40	14		2.10		25	2.35	2.10	
4		1.60	1.40	15		2.10		26	2.35	2.10	
5		1.60	1.40	16		2.10		27	1.82	2.10	
6		1.60	1.40	17		2.10		28	1.76	1.49	
7		1.91	1.40	18		2.10		29	1.73	1.45	
8		2.23	1.40	19		2.10		30	1.73	1.45	
9		2.18		20		2.10		31	1.67	1.45	
10		2.18		21		2.10					
11		2.18		22	2.40	2.10					

ARKANSAS RIVER AT SALIDA, COLORADO.

This station is located at the footbridge near the railroad shops at Salida, Colorado. It was established April 11, 1895, and has been maintained during a portion of each year since. The gage rod, a vertical timber, is fastened to the north side of the footbridge, but considerable difficulty has been experienced by its being knocked out by ice and by logs during high water, three new rods being necessary in 1900. The banks are high and do not overflow. The bed of the stream consists of sand, gravel, and bowlders. Two large bowlders interfere to a great extent with the accuracy of the results. As the station is an important one, these bowlders should be removed, so as to improve the character of the channel, and thus render the results of measurements more reliable. A durable gage rod could be constructed on the left bank of the stream by laying a heavy timber in an inclined position. The stream is very swift at this point, but the channel is straight, and the discharge can readily be measured from the footbridge. Little water is used above Salida, and none is used below that place until Canyon is reached. The observer is William Furniss, who has kept the records for the last two years, the gage heights being sent to the local forecast official of the Weather Bureau at Denver, who has had them published in the morning papers.

A brief description of this station was published in Water-Supply

Paper No. 37, page 258. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 230. During 1900 the following measurements were made by A. L. Fellows:

August 8: Gage height, 1.08 feet; discharge, 443 second-feet.
August 22: Gage height, 0.88 foot; discharge, 364 second-feet.
March 15: Gage height, 0.90 foot: discharge, 271 second-feet.
June 14: Gage height, 4.30 feet; discharge, 3,036 second-feet.

Daily gage height, in feet, of Arkansas River at Salida, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	0.40	0.95	5.00	1.90	0.95	0.70	0.80
2	.40	1.25	4.60	2.00	.90	.70	.80
3	.30	1.45	4.40	1.85	.90	.70	.80
4	.30	1.55	4.10	1.65	.90	.70	.75
5	.30	1.80	3.75	1.85	.90	.70	.70
6	.40	1.90	3.75	1.90	.90	.70	.70
7	.50	2.00	4.10	1.60	.90	.75	.70
8	.40	2.00	4.45	1.50	1.00	.85	.70
9	.40	2.15	4.65	1.25	1.00	.90	.70
10	.40	2.45	4.40	1.20	1.05	.90	.70
11	.35	2.60	3.40	1.20	1.10	1.00	.70
12	.30	2.60	2.80	1.10	1.00	.90	.60
13	.30	2.60	2.80	1.10	1.00	.90	.60
14	.30	2.70	3.00	1.20	.90	.90	.60
15	.30	2.60	2.75	1.05	.90	.85	.60
16	.30	2.60	2.80	1.15	.80	.80	.60
17	.30	2.60	2.80	1.20	.80	.80	.60
18	.30	2.60	2.65	1.20	.80	.80	.60
19	.35	2.70	2.55	1.35	.80	.80	.55
20	.55	3.00	2.35	1.40	.80	.80	.50
21	.60	3.10	2.50	1.30	.80	.80	.50
22	.70	3.00	2.80	1.30	.80	.90	.50
23	.85	3.20	2.80	1.30	.80	.90	.50
24	.80	3.60	3.10	1.40	.80	.80	.50
25	.80	3.80	2.80	1.35	.80	.80	.50
26	.80	4.10	2.65	1.30	.80	.80	.50
27	.70	4.20	1.95	1.30	.80	.80	.50
28	.70	4.30	2.00	1.15	.80	.80	.50
29	.95	4.50	2.00	1.10	.70	.80	.45
30	1.10	4.60	1.85	1.00	.70	.80	.40
31	.....	5.00	.....	1.00	.70	.....	.40

ARKANSAS RIVER NEAR CANYON, COLORADO.

This station is located at the Hot Springs Hotel, 1½ miles west of Canyon and a short distance below the mouth of Grape Creek. It was established in 1889, and records have been kept since that time, thus furnishing most valuable data of the discharge of the river. The station is of special importance, being located at the mouth of the canyon and at a point practically above all of the irrigation ditches, except the Canyon City ditch (sometimes called the North Side ditch) and the South Canyon ditch (sometimes called the South Side ditch), both of which head above the station. During the irrigation season each of these ditches carries from 25 to 60 cubic feet of water per second, according to the needs of the irrigators, and their discharge should be added to the discharge at the station in order to obtain the total run-off at the mouth of the canyon. The gage rod is an inclined timber fastened to the north end of the suspension bridge belonging to the Hot Springs Hotel. The channel is straight for a long distance, and being lined with bowlders it does not readily

change, thus furnishing an opportunity to obtain fairly accurate results. The observer is G. A. Prentiss, manager of the Hot Springs Hotel. During 1900 the following measurements were made of the two ditches mentioned:

Discharge measurements of Canyon City and South Canyon ditches.

Date.	Canyon City ditch.	South Canyon ditch.
1900.	*Sec.-ft.*	*Sec.-ft.*
March 14	8	21
June 14	68	50
July 20	56	51
September 8	58	31

A description of this station was published in Water-Supply Paper No. 37, page 258. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 231. During 1900 the following measurements were made by A. L. Fellows and R. W. Hawley:

March 14: Gage height, 2.85 feet; discharge, 408 second-feet.
June 14: Gage height, 5.50 feet; discharge, 3,235 second-feet.
July 20: Gage height, 2.85 feet; discharge, 570 second-feet.
September 8: Gage height, 2.10 feet; discharge, 229 second-feet.
September 12: Gage height, 2.10 feet; discharge, 205 second-feet.

Daily gage height, in feet, of Arkansas River near Canyon, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	2.90	3.45	6.65	4.45	2.40	2.10	2.10	2.10	2.50
2	.....	.....	.....	3.00	3.40	6.60	4.25	2.35	2.15	2.10	2.10	2.50
3	.....	2.50	2.70	3.00	3.30	6.45	4.20	2.40	2.10	2.10	2.10	2.50
4	.....	.....	.....	3.00	3.30	6.30	4.15	2.35	2.10	2.10	2.20	2.40
5	.....	.....	.....	3.10	3.40	6.25	3.85	2.30	2.10	2.10	2.30	2.40
6	2.60	.....	.....	3.10	3.40	6.20	3.80	2.50	2.10	2.10	2.30	2.40
7	.....	.....	.....	3.10	3.50	6.35	3.70	2.45	2.10	2.10	2.30	2.40
8	.....	.....	.....	3.10	3.60	6.50	3.45	2.45	2.10	2.10	2.30	2.40
9	.....	.....	.....	3.10	3.70	6.40	3.75	2.55	2.10	2.10	2.25	2.40
10	.....	2.60	2.80	3.10	3.90	6.35	3.90	2.60	2.10	2.15	2.20	2.40
11	.....	.....	.....	3.10	4.05	6.15	3.45	2.55	2.10	2.20	2.25	2.40
12	.....	.....	.....	3.10	4.45	5.65	3.45	2.40	2.15	2.20	2.20	2.50
13	2.60	.....	.....	3.10	4.50	5.75	3.45	2.45	2.10	2.25	2.20	2.40
14	.....	.....	.....	3.20	4.45	5.65	3.35	2.55	2.10	2.30	2.20	2.40
15	.....	.....	.....	3.20	4.40	5.60	3.20	2.40	2.10	2.35	2.20	2.30
16	.....	.....	.....	3.20	4.35	5.40	3.30	2.30	2.10	2.35	2.20	2.30
17	.....	2.60	2.80	3.20	4.45	5.50	3.20	2.20	2.10	2.40	2.25	2.40
18	.....	.....	.....	3.20	4.85	5.45	3.00	2.15	2.05	2.40	2.30	2.40
19	.....	.....	.....	3.30	4.90	5.45	3.00	2.15	2.00	2.35	2.30	2.40
20	2.50	.....	.....	3.45	5.05	5.35	2.95	2.10	2.00	2.30	2.30	2.40
21	.....	.....	.....	3.50	4.95	5.30	2.90	2.20	2.00	2.20	2.30	2.40
22	.....	.....	.....	3.50	4.80	5.35	2.85	2.20	2.00	2.20	2.30	2.50
23	.....	.....	.....	3.40	4.90	5.35	2.80	2.20	2.00	2.20	2.30	2.50
24	.....	2.60	2.80	3.40	4.90	5.55	3.00	2.15	2.00	2.20	2.40	2.40
25	.....	.....	.....	3.30	5.25	5.65	2.85	2.15	2.00	2.20	2.40	2.30
26	.....	.....	.....	3.30	5.60	5.25	2.85	2.25	2.05	2.20	2.40	2.30
27	2.50	.....	.....	3.20	5.95	5.05	2.90	2.20	2.15	2.20	2.50	2.30
28	.....	.....	.....	3.20	6.25	5.05	2.80	2.20	2.10	2.15	2.50	2.40
29	.....	.....	.....	3.45	6.65	4.60	2.65	2.15	2.00	2.10	2.50	2.40
30	.....	.....	.....	3.65	6.46	4.55	2.55	2.10	2.10	2.10	2.50	2.40
31	.....	.....	2.90	.....	6.65	.....	2.35	2.15	.....	2.10	.....	2.40

ARKANSAS RIVER AT PUEBLO, COLORADO.

This station, which was established in September, 1894, is located at the Union avenue bridge in the city of Pueblo. Until March, 1900, the gage rod was a 2-inch by 6-inch plank bolted to the masonry wall at the south end of the Main street bridge, but owing to the scouring of the channel it became necessary to replace the gage by one about 69 feet below the south end of the Union avenue bridge. Discharge measurements, however, are still made at the Main street bridge. The channel at this point is excellent, and it would be of very great value to the entire division to have a permanent station of concrete established here. The channel, which is of bowlders and gravel, is confined by high masonry walls, so that there is little change, except that it fills during low water and scours out during high water. The flow of the stream is rapid, but not too swift for accurate measurements. This station is an important one, being located near the head of the principal irrigation portion of the valley, only one ditch of importance being taken out above it in the Pueblo district, although considerable water is used in the ditches in the neighborhood of Canyon, which is in another water district. It is upon the gagings made at this point that the water superintendents and commissioners depend for distribution of water to ditches below. The present gage rod is a 2-inch by 6-inch vertical timber, bolted, like the former rod, to the masonry wall and marked in feet and tenths. On June 13, 1900, the gage rod was connected with a bench mark on the coping at the northwest corner of the Union avenue bridge, which was found to be 19.79 feet above the zero of the rod. The gage readings during 1900 have been made by T. J. Burrows, water commissioner of the Pueblo water district.

Gage heights at this station during 1899 were published in Water-Supply Paper No. 37, page 259. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 232. During 1900 the following measurements were made by A. L. Fellows, C. W. Beach, and R. W. Hawley:

Discharge measurements of Arkansas River at Pueblo, Colorado.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
March 3	2.17	498	July 17	2.50	751
March 16	2.05	435	July 21	2.25	583
April 8	2.34	675	September 3	1.35	153
April 12	2.15	608	September 5	1.43	191
May 21	5.70	5,072	September 7	1.40	174
June 13	5.10	3,963	September 25	1.82	346

Daily gage height, in feet, of Arkansas River at Pueblo, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	1.90	1.75	1.60	3.75	5.65	3.75	2.00	1.30	1.60	1.85	1.90
2	2.00	1.85	1.80	1.56	3.55	6.75	3.55	1.90	1.40	1.60	1.90	1.90
3	2.05	1.90	1.85	1.50	3.50	6.10	3.35	1.90	1.40	1.60	1.90	1.90
4	2.20	1.85	2.00	1.50	3.40	6.20	3.30	1.80	1.40	1.60	1.90	1.80
5	2.10	1.80	1.95	4.55	3.40	5.45	3.25	1.80	1.50	1.52	1.95	1.90
6	1.95	1.80	1.95	2.60	3.80	5.60	3.10	1.80	1.45	1.50	1.95	1.90
7	1.95	1.90	1.80	2.40	3.80	5.50	2.95	1.80	1.40	1.50	1.90	1.90
8	1.95	1.50	1.80	2.40	3.80	5.95	2.90	1.75	1.40	1.55	1.90	1.90
9	1.90	1.60	1.75	2.40	3.80	6.00	3.15	1.90	1.40	1.62	1.90	1.90
10	1.85	1.85	1.76	2.45	4.10	5.80	2.95	2.10	1.40	1.62	1.90	1.90
11	1.85	1.90	1.80	2.25	4.25	5.60	2.65	1.90	2.00	1.70	1.90	1.90
12	1.85	1.95	1.90	2.20	4.50	5.15	2.90	1.80	1.60	1.70	1.90	1.90
13	1.85	1.90	2.00	2.20	4.40	5.10	2.85	1.80	1.60	1.70	1.90	1.90
14	1.90	1.95	2.15	2.20	4.25	5.00	2.70	1.80	1.50	1.70	1.90	1.90
15	1.95	1.95	2.10	2.75	4.10	5.10	2.70	1.70	1.50	1.70	1.90	1.90
16	2.00	1.95	2.00	1.95	3.95	4.90	2.70	1.70	1.50	1.80	1.90	1.90
17	1.95	1.90	1.95	2.30	4.00	5.00	2.55	1.70	1.55	1.90	1.90	1.90
18	1.90	1.95	2.00	2.40	4.30	4.90	2.45	1.70	1.50	1.90	2.00	1.90
19	1.75	2.05	2.00	2.40	4.30	4.70	2.40	1.70	1.50	1.90	2.00	1.90
20	1.85	2.20	2.00	2.45	5.90	4.75	2.40	1.65	1.49	1.80	2.00	1.70
21	1.90	2.15	1.90	2.85	5.45	4.70	2.30	1.60	1.58	1.80	2.00	1.90
22	1.95	2.00	1.80	3.00	4.80	4.70	2.30	1.60	1.51	1.80	2.00	1.80
23	1.90	2.05	1.80	2.95	4.70	4.85	2.30	1.60	1.55	1.80	2.00	1.80
24	1.90	2.05	1.80	2.75	4.90	4.80	3.00	1.60	1.60	1.80	2.00	1.80
25	1.75	2.00	1.80	2.65	5.20	5.05	2.50	1.50	1.60	1.80	2.00	1.80
26	1.80	1.90	1.80	2.65	5.20	4.45	2.20	1.50	1.50	1.80	2.00	1.90
27	1.75	2.00	1.80	2.50	5.20	4.45	2.20	1.50	1.65	1.80	2.10	1.80
28	1.80	1.95	1.80	2.75	5.50	4.10	2.00	1.50	1.70	1.80	2.10	1.80
29	1.90	.....	1.80	3.35	6.00	3.95	1.75	1.45	1.70	1.80	2.10	1.90
30	1.80	.....	1.60	4.25	6.60	3.85	2.15	1.40	1.70	1.80	2.00	1.90
31	1.85	.....	1.60	.....	6.20	.....	2.15	1.40	.....	1.85	.....	1.90

ARKANSAS RIVER NEAR NEPESTA, COLORADO.

This station, which is located at the wagon bridge a short distance above the town of Nepesta, is maintained by The Great Plains Water Company. It was established September 8, 1897, and has been maintained during the irrigation seasons of 1898, 1899, and 1900. The gage rod consists of a vertical timber securely fastened to the upstream cylinder of the bridge, on the left side of the river, readings at low water being made by means of a small temporary gage on the right-hand side. The channel above and below the station is straight for several hundred feet. The bed is sandy and shifting, so that the results are not altogether satisfactory for the purpose of making a rating table. The observer is J. A. Braun, railway station agent at Nepesta. A brief description of this station was published in Water-Supply Paper No. 37, page 260. The results of measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 233. During 1900 the following measurements were made by C. W. Beach and R. W. Hawley:

April 12: Gage height, 4.30 feet; discharge, 1,101 second-feet.
October 8: Gage height, 3.70 feet; discharge, 146 second-feet.

Daily gage height, in feet, of Arkansas River near Nepesta, Colorado, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a6.4	7.2	5.7	4.5	3.4	3.7	3.9	3.9
2	a6.4	7.5	5.5	4.4	3.3	3.7	3.9	.....
3	6.4	8.0	5.3	4.2	3.3	3.7	3.9	.....
4	6.1	7.3	5.2	4.2	3.1	3.7	3.9	.....
5	6.0	7.1	5.1	4.1	3.1	3.5	4.0	.....
6	6.4	7.0	4.9	3.9	3.2	3.5	3.8	.....
7	6.5	7.0	4.7	3.7	3.2	3.6	3.7	.....
8	6.5	7.0	4.7	3.7	3.3	3.7	3.7	.....
9	6.4	6.8	4.6	3.9	2.9	3.7	3.6	.....
10	6.7	7.0	4.7	4.0	3.0	3.8	3.3	.....
11	7.0	6.9	4.6	3.8	3.0	3.7	3.4	.....
12	7.4	6.8	4.5	3.5	3.1	3.5	3.4	.....
13	7.0	6.6	4.6	3.5	3.6	3.5	3.9	.....
14	6.7	6.5	4.5	3.5	3.5	3.6	3.8	.....
15	6.8	6.5	4.4	3.5	3.4	3.7	4.0	.....
16	6.5	6.5	4.3	3.5	2.9	3.9	3.9	.....
17	6.3	6.5	4.2	3.3	3.2	3.9	4.1	.....
18	6.5	6.8	4.1	3.3	3.4	4.0	4.1	.....
19	6.5	6.4	4.0	3.1	3.4	4.0	4.1	.....
20	7.0	6.2	3.9	3.2	3.3	3.9	4.0	.....
21	9.0	6.3	3.9	3.0	3.5	3.8	4.0	.....
22	7.5	6.4	3.8	3.1	3.1	3.8	4.0	.....
23	7.4	6.5	3.8	3.1	3.1	3.8	3.9	.....
24	7.0	6.5	4.1	3.1	3.5	3.8	3.9	.....
25	6.8	6.5	5.5	3.1	3.6	4.0	3.9	.....
26	7.0	6.4	5.0	2.9	3.6	4.0	3.9	.....
27	7.1	6.3	4.9	2.9	3.2	3.9	3.9	.....
28	7.3	6.2	4.2	3.0	3.3	3.7	4.0	.....
29	7.7	6.1	4.1	3.0	3.4	4.0	4.0	.....
30	8.1	5.9	4.9	3.0	3.8	3.9	4.0	.....
31	7.5	.....	4.6	3.1	.....	3.9	.....	.....

a Estimated.

ARKANSAS RIVER NEAR ROCKYFORD, COLORADO.

This station is located about 2 miles northeast of Rockyford, at a wagon bridge crossing the river. It was established May 3, 1897, by S. W. Cressy, water commissioner of that district. Mr. Cressy maintained the station as long as he remained in charge of the office, but since then no reports have been received. The last report is dated April 7, 1900. The river is straight for a distance above and below the bridge, but the bed is very sandy, and changes radically at different stages of the water, so that the results obtained from any single rating table should be considered approximate. A better location for the station is at the ford about 3 miles above. A brief description of the station was published in Water-Supply Paper No. 37, page 261. Results for 1897 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 234. The figures for 1898 were published in the Nineteenth Annual Report, Part IV, page 338.

Daily gage height, in feet, of Arkansas River near Rockyford, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	.....	1.28	1.18	1.19	12	.....	(a)	1.20	.....	23	1.00	(b)	1.05	.....
2	.....	1.23	1.20	1.20	13	.....	(a)	1.20	.....	24	1.00	(b)	1.00	.....
3	.....	1.25	1.04	1.20	14	.....	(a)	1.20	.....	25	1.07	1.20	1.00	.....
4	.....	1.28	1.12	1.20	15	.....	(a)	1.28	.....	26	1.13	1.20	1.09	.....
5	.....	1.30	1.22	2.75	16	1.15	(a)	1.20	.....	27	1.15	1.20	1.10	.....
6	.....	1.25	1.25	3.95	17	1.18	(a)	1.20	.....	28	1.20	1.10	1.14	.....
7	.....	1.28	1.25	3.30	18	1.18	(b)	1.19	.....	29	1.25	.....	1.17	.....
8	.....	1.30	1.18	.....	19	1.10	(b)	1.25	.....	30	1.30	.....	1.20	.....
9	.....	1.25	1.10	.....	20	1.10	(b)	1.18	.....	31	1.30	.....	1.20	.....
10	.....	(a)	1.10	.....	21	1.05	(b)	1.12	.....					
11	.....	(a)	1.05	.....	22	1.00	(b)	1.08	.....					

a Frozen. *b* No record.

ARKANSAS RIVER AT PROWERS, COLORADO.

This station was established in September, 1899, but no records were kept until the spring of 1900. It is at the diversion dam across the river at the head of the Colorado and Kansas canal, that point being selected in the hope that the channel there might prove to be permanent, which up to the present time has been the case, and the rating curve obtained gives excellent results within the limits of the measurements made. The station is of special importance, as it is practically at the head of irrigation district No. 67, only the Colorado and Kansas canal and the Peterson ditch being taken out above in that district. The gage rod consists of a piece of board fastened to the upper side of the right-hand wing of the dam, the zero of the rod being level with the lowest place on the crest of the dam. During the greater part of the year little water passes this point, and during the low stages water is so valuable that the greatest care should be exercised in its distribution. The observer is D. L. Birge, head-gate keeper of the Colorado and Kansas canal. During 1900 the following measurements were made by A. L. Fellows and C. W. Beach:

July 19: Gage height, 0.38 foot; discharge, 113 second-feet.
July 5: Gage height, 0.60 foot; discharge, 304 second-feet.
July 28: Gage height, 0.775 foot; discharge, 546 second-feet.

When the last measurement was made 60 second-feet was going into the ditches.

Daily gage height, in feet, of Arkansas River at Prowers, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Nov.	Dec.
1		4.10	2.60	0.90	0.20	(a)	0.15
2		3.10	2.70	.70	.20		.10
3		2.80	3.00	.50	.15		.10
4		2.70	3.50	.40	.15		.20
5		2.30	3.00	.40	.10		.20
6		2.20	3.10	.30	.10		.20
7		2.20	2.70	.30	.20		.15
8		2.20	2.30	.20	.30		.20
9		2.20	2.30	.20	.20		.20
10		2.30	2.20	.20	.30		.30
11		2.30	2.40	.20	.40		.20
12		2.90	2.90	.15	.70		.20
13		2.20	2.40	.15	.60		.20
14		2.70	2.30	.20	.50		.10
15	1.30	2.60	2.10	.20	.40		.15
16	1.20	2.40	2.00	.20	.30		.20
17	1.20	2.20	2.00	.05	.10		.20
18	3.70	2.10	1.80	.05	.00		.20
19	2.30	2.30	1.80	.15	(a)		.30
20	1.90	2.10	1.70	.10			.25
21	2.20	2.20	1.50	.15			.20
22	1.70	3.40	1.80	.15			.20
23	1.80	3.10	1.80	.15			.20
24	1.70	2.80	1.40	.15			.20
25	2.80	2.60	1.20	.25		0.20	.30
26	2.60	2.50	1.30	.40		.10	.20
27	1.30	2.50	1.20	1.50		.10	.20
28	1.10	2.50	1.10	.90		.10	.30
29	4.90	2.40	.90	.70		.10	.20
30	4.70	2.40	1.20	.50		.20	.20
31		3.10		.25			.20

a No record from August 19 to November 24; water being diverted into irrigation canals.

ARKANSAS RIVER AT AMITY CANAL HEAD GATES, COLORADO.

The station is located at the head of Amity canal, 7 miles west of Lamar, and is maintained by the Amity Canal Company, which keeps the records of the amount of water flowing into the ditch, over the dam, and out of the wasteway of the canal. No measurements were made at this point during 1900. On April 7, 1900, E. R. Bannister, head-gate keeper of the Amity canal, made a single measurement at the wagon bridge crossing the river north of Lamar, and found a discharge of 8,890 second-feet.

ARKANSAS RIVER NEAR GRANADA, COLORADO.

This station was established July 24, 1898, being located at the head gates of the Buffalo Creek canal, 2 miles northeast of Granada. There is an earth and brush dam across the river at that point, but owing to its unstable nature the gage heights are of little value, giving, as they do, merely an idea of the rise and fall of the river, without particular reference to the actual discharge. Since the establishment of the station readings have been made throughout the irrigation seasons (1898, 1899, and 1900) by Ben Riley, head-gate keeper of the Buffalo canal. No measurements have been made at this point, and no rating table has been computed. A brief description of the station, with gage heights for 1899, was published in Water-Supply Paper No. 37, page 264.

Daily gage height, in feet, of Arkansas River near Granada, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	2.60	2.00	1.20	4.70	3.90	2.00	1.60	1.40	1.80	1.80	1.80
2	3.60	3.60	2.00	1.20	4.00	4.00	2.00	1.60	1.40	1.60	1.80	1.80
3	3.60	3.60	2.00	1.00	4.30	4.60	1.80	1.60	1.40	1.00	1.80	1.80
4	3.60	3.40	1.80	1.80	4.80	4.60	1.80	1.60	1.40	1.00	1.80	1.80
5	3.60	3.00	1.80	2.80	4.50	4.00	2.40	1.60	1.60	1.00	1.80	1.80
6	3.60	2.80	1.80	3.40	4.10	3.40	2.40	1.40	1.40	1.00	1.80	2.00
7	3.60	2.60	1.60	3.50	3.40	3.20	2.40	1.40	1.40	1.00	1.80	2.00
8	3.60	2.00	1.40	3.60	3.10	3.00	2.60	1.40	1.20	1.40	1.80	2.00
9	3.60	2.00	1.40	3.00	3.00	2.80	3.00	1.50	1.20	1.60	1.80	.....
10	3.60	2.00	1.40	2.60	3.00	2.80	3.60	1.60	1.20	1.50	1.80	.....
11	3.60	2.00	1.40	3.00	3.00	3.15	3.60	1.80	1.20	1.60	1.80	.....
12	3.60	2.80	1.40	2.80	2.80	3.35	3.60	1.60	1.80	1.60	1.80	.....
13	3.60	2.80	1.60	2.80	3.50	3.00	3.00	1.60	1.60	1.60	1.80	.....
14	3.00	2.40	1.60	2.40	3.60	3.10	3.00	1.80	1.60	1.60	1.80	.....
15	3.00	2.00	1.40	2.60	3.50	3.00	2.80	1.60	1.60	1.60	1.80	.....
16	3.00	2.00	1.40	2.60	3.30	3.00	3.70	1.60	1.40	1.60	1.80	.....
17	3.00	2.40	1.80	3.80	3.30	2.90	3.20	1.60	1.40	1.60	1.80	.....
18	2.80	2.60	1.80	3.80	3.20	3.00	3.00	1.60	1.60	1.60	1.80	.....
19	2.80	2.60	1.80	3.60	3.20	3.00	3.00	1.35	1.60	1.80	1.80	.....
20	2.80	2.60	1.80	3.40	3.50	3.00	2.80	1.35	1.60	1.80	2.00	.....
21	2.00	2.80	1.40	3.00	3.90	3.00	2.00	1.35	1.60	1.60	2.00	.....
22	2.00	3.00	1.40	3.00	4.00	2.80	2.00	1.60	1.60	1.60	2.00	.....
23	2.00	2.60	.80	3.30	3.80	2.60	2.00	1.35	1.60	1.60	2.00	.....
24	2.00	2.60	.80	2.70	3.40	2.60	2.00	.80	1.60	1.60	2.00	.....
25	2.00	2.80	.80	2.20	3.40	2.00	2.00	.90	1.60	1.60	1.80	.....
26	2.00	2.40	.80	2.00	3.40	2.00	2.00	1.40	1.60	1.60	1.80	.....
27	2.00	2.00	.80	2.00	3.20	2.00	2.00	1.40	1.80	1.60	1.80	.....
28	1.80	2.00	.80	2.00	3.20	2.00	2.00	1.40	1.80	1.80	1.80	.....
29	1.80	.....	1.60	2.40	3.20	1.80	3.00	1.40	1.80	1.80	1.80	.....
30	2.60	.....	1.60	3.80	3.80	3.40	2.20	1.40	1.80	1.80	1.80	.....
31	2.60	.....	1.60	.....	3.70	.....	1.70	1.40	.....	1.80	.....	.....

ARKANSAS RIVER AT HUTCHINSON, KANSAS.

This station was established May 13, 1895. It is described in Water-Supply Paper No. 37, page 265. On October 25, 1900, a new gage was put in. It is a pine timber, 2 inches by 2 inches by 5 feet long, marked in feet and tenths, and is fastened to the east side of the east cylinder of the third set of cylinders from the north end of the bridge, at the same elevation as the old gage. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 233; for 1897, Nineteenth Annual Report, Part IV, page 361; for 1898, Twentieth Annual Report, Part IV, page 343; for 1899, Twenty-first Annual Report, Part IV, page 236. During 1900 the following discharge measurements were made by W. G. Russell:

Discharge measurements of Arkansas River at Hutchinson, Kansas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 12	4.65	6,321	June 20	4.05	3,901
April 13	4.25	4,738	September 27	1.35	77
April 14	4.10	3,887	October 25	1.30	87
May 18	4.75	5,989	November 29	1.30	84
June 9	5.10	8,476			

Daily gage height, in feet, of Arkansas River at Hutchinson, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	2.00	2.00	1.80	3.70	4.60	3.20	1.50	1.10	1.70	1.45	1.30
2	1.80	2.00	2.10	1.80	3.65	4.70	3.10	1.50	.95	1.65	1.45	1.30
3	1.80	2.00	2.20	1.70	3.60	5.00	3.00	1.45	.95	1.60	1.45	1.30
4	1.90	2.00	2.30	1.70	5.20	4.80	2.90	1.45	.95	1.50	1.35	1.30
5	1.90	1.90	3.20	1.70	5.35	4.80	2.80	1.40	.95	1.40	1.35	1.30
6	1.90	1.90	3.00	1.70	5.10	5.20	2.70	1.40	.95	1.35	1.25	1.30
7	2.00	1.90	2.80	1.70	4.90	5.55	2.70	1.40	.90	1.30	1.25	1.25
8	1.90	1.90	2.70	1.70	4.90	5.40	2.70	1.50	.90	1.30	1.25	1.25
9	1.90	1.90	2.70	1.70	4.70	5.20	2.60	1.45	.90	1.30	1.25	1.25
10	1.90	1.90	2.70	4.65	4.50	5.00	2.50	1.40	1.30	1.25	1.25	1.25
11	1.90	1.90	2.60	4.75	4.30	4.60	2.40	1.35	1.20	1.20	1.25	1.25
12	2.00	1.90	2.50	4.65	4.20	4.60	2.30	1.30	1.20	1.20	1.25	1.25
13	2.00	1.90	2.50	4.60	4.20	4.70	2.20	1.25	1.20	1.20	1.25	1.25
14	2.00	1.90	2.50	4.25	4.10	4.90	2.10	1.20	1.20	1.20	1.25	1.25
15	2.10	1.90	2.40	4.10	4.15	4.70	2.10	1.15	1.15	1.20	1.25	1.25
16	2.10	1.90	2.30	4.00	4.40	4.90	2.00	1.10	1.10	1.15	1.25	1.25
17	2.10	1.90	2.20	3.90	4.60	4.70	1.90	1.05	1.10	1.10	1.25	1.25
18	2.10	2.00	2.20	3.80	4.75	4.60	1.90	1.05	1.10	1.10	1.20	1.25
19	2.10	2.00	2.10	3.60	4.50	4.30	1.90	1.05	1.20	1.10	1.15	1.25
20	2.10	2.00	2.00	4.50	4.40	4.10	1.85	1.00	1.25	1.10	1.20	1.25
21	2.10	2.00	2.00	5.30	4.20	4.00	1.80	1.00	1.20	1.30	1.25	1.25
22	2.10	2.00	2.00	4.60	4.20	3.90	1.70	1.25	1.20	1.45	1.25	1.25
23	2.10	1.90	1.90	4.35	4.20	3.80	1.70	1.20	1.25	1.35	1.25	.....
24	2.00	1.90	1.90	4.00	4.20	3.70	1.70	1.20	1.25	1.30	1.25	.....
25	2.00	1.90	1.90	4.10	4.05	3.60	1.70	1.10	1.20	1.25	1.25	.....
26	2.00	2.00	1.90	4.10	5.10	3.50	1.60	1.10	1.15	1.30	1.25	.....
27	2.00	2.00	1.90	4.00	5.20	3.50	1.60	1.05	1.35	1.30	1.25	.....
28	2.00	2.00	1.90	4.10	4.80	3.50	1.55	1.05	1.40	1.35	1.30	.....
29	2.00	.....	1.90	4.05	4.70	3.50	1.50	1.10	1.50	1.50	1.30	.....
30	2.00	.....	1.90	3.90	4.50	3.40	1.50	1.10	1.70	1.60	1.30	.....
31	2.00	.....	1.90	.....	4.60	.....	1.50	1.10	.....	1.50	.....	.....

VERDIGRIS RIVER NEAR LIBERTY, KANSAS.

This station, which was originally established in August, 1895, is described in Water-Supply Paper No. 37, page 265. In 1900 a new

bench mark was established, consisting of 3 nails driven horizontally into a root on the river side of a cottonwood tree 40 feet south of the gage, the nails being 8 inches below a sandstone rock which protrudes from a hollow in the tree. Its elevation is 11.88 feet above the zero of the old gage. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 235; for 1897, Nineteenth Annual Report, Part IV, page 369; for 1898, Twentieth Annual Report, Part IV, page 344; for 1899, Twenty-first Annual Report, Part IV, page 237. During 1900 the following discharge measurements were made by W. G. Russell:

May 16: Gage height, 2.90 feet; discharge, 265 second-feet.
June 11: Gage height, 3.40 feet; discharge, 542 second-feet.
June 23: Gage height, 2.40 feet; discharge, 169 second-feet.
October 1: Gage height, 34.70 feet; discharge, 35,000 second-feet.[1]
October 28: Gage height, 3.00 feet; discharge, 437 second-feet.
November 28: Gage height, 4.00 feet; discharge, 885 second-feet.

Daily gage height, in feet, of Verdigris River near Liberty, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.05	2.00	2.50	2.60	4.45	4.40	26.65	2.45	1.60	34.75	24.75	4.00
2	2.00	2.00	2.60	2.60	3.90	4.25	13.20	2.40	1.65	34.70	27.95	3.80
3	2.00	2.00	2.65	2.50	3.65	3.90	4.20	2.30	1.80	5.75	26.90	3.80
4	2.00	2.00	2.70	2.50	3.55	3.60	3.70	2.30	1.95	5.20	16.50	3.80
5	2.10	2.00	4.60	2.40	3.20	3.40	4.00	2.20	1.85	4.80	7.50	3.70
6	2.10	1.90	13.00	2.40	6.10	3.25	4.20	2.20	1.70	4.35	5.80	3.70
7	2.10	1.90	16.10	2.40	4.30	3.10	3.45	2.10	1.70	4.00	5.45	3.60
8	2.10	1.90	11.45	2.40	4.10	2.95	2.95	2.10	1.70	3.80	5.15	3.60
9	2.10	2.10	6.20	2.40	4.90	2.75	2.75	2.10	1.70	3.65	4.95	3.60
10	2.10	2.20	5.60	2.40	4.15	2.65	3.00	2.10	1.70	3.50	4.80	3.50
11	2.10	2.10	5.25	2.45	3.55	3.30	2.85	2.10	1.70	3.40	4.70	3.40
12	2.20	2.10	4.85	2.50	3.25	3.15	3.60	2.10	1.80	3.30	4.60	3.40
13	2.20	2.10	4.45	2.60	3.10	3.05	3.35	2.00	1.80	3.20	4.45	3.30
14	2.20	2.25	3.95	2.60	2.90	3.80	2.95	2.00	1.70	3.15	4.40	3.30
15	2.20	2.30	3.75	2.90	2.80	4.55	2.75	2.00	1.80	3.05	4.30	3.30
16	2.10	2.30	3.35	2.80	2.85	3.40	6.30	2.00	1.70	3.00	4.20	3.20
17	2.00	2.20	3.20	16.65	10.85	3.10	9.25	1.90	1.75	2.90	4.10	3.20
18	2.00	2.00	3.20	10.50	21.50	2.90	7.65	1.90	2.45	2.90	4.00	3.20
19	2.00	2.00	3.15	6.70	20.55	2.80	4.70	1.80	2.85	2.90	4.10	3.20
20	2.00	2.00	3.10	5.40	10.75	2.65	3.75	1.70	2.75	2.80	5.00	3.20
21	2.00	2.00	3.10	3.90	7.30	2.55	3.15	1.70	2.85	2.80	5.10	3.10
22	2.10	2.00	3.05	3.80	5.40	2.45	3.00	1.70	2.85	2.95	4.80	3.10
23	2.10	2.00	2.95	3.85	5.10	2.40	2.95	1.70	2.80	2.90	4.80	3.10
24	2.00	2.05	2.80	7.25	5.05	2.40	4.75	1.60	2.70	3.40	4.50	3.10
25	2.00	2.70	2.80	6.50	6.70	2.35	4.80	1.60	4.55	3.40	4.30	3.10
26	2.00	2.55	2.80	5.25	5.50	2.30	3.90	1.90	13.45	3.35	4.10	3.10
27	2.00	2.45	2.80	5.00	6.00	2.30	3.20	1.75	12.10	3.10	4.10	3.00
28	2.00	2.40	2.80	4.90	6.05	2.30	3.00	1.55	28.00	3.00	4.10	3.00
29	2.00	.....	2.70	3.90	5.65	3.20	2.90	1.60	32.00	2.90	4.00	3.00
30	2.00	.....	2.70	4.35	5.30	10.50	3.10	1.60	36.00	8.75	4.00	.....
31	2.00	.....	2.70	.....	4.60	.....	2.65	1.60	.....	15.80	.....	.....

NEOSHO RIVER NEAR IOLA, KANSAS.

This station, which was established in July, 1895, is described in Water-Supply Paper No. 37, page 267. Records of discharge measurements for the years 1896, 1897, 1898, and 1899 will be found in the Twenty-first Annual Report, Part IV, pages 245 and 246. During

[1] Partly estimated; 33,048 second-feet measured.

1900 the following discharge measurements were made by W. G. Russell:

May 15: Gage height, 2.80 feet; discharge, 414 second-feet.
June 12: Gage height, 3.40 feet; discharge, 637 second-feet.
June 23: Gage height, 3.20 feet; discharge, 489 second-feet.
October 2: Gage height, 5.80 feet; discharge, 4,476 second-feet.
October 29: Gage height, 7.10 feet; discharge, 7,559 second-feet.
November 27: Gage height, 3.30 feet; discharge, 788 second-feet.

Daily gage height, in feet, of Neosho River near Iola, Kansas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.30	2.60	2.80	4.00	5.25	5.50	3.20	2.10	7.80	17.40	3.20
2	2.20	2.30	2.60	2.80	3.90	4.15	4.20	2.95	2.10	5.55	18.95	3.10
3	2.20	2.30	2.60	2.80	3.50	3.90	3.50	2.75	2.10	4.70	12.50	3.10
4	2.20	2.30	2.70	2.70	3.50	3.80	3.30	2.60	2.10	3.95	5.30	3.00
5	2.20	2.30	3.05	2.70	3.50	3.70	3.30	2.50	2.10	3.60	4.90	3.00
6	2.20	2.30	8.00	2.70	3.40	3.70	3.20	2.45	2.10	3.40	4.45	3.00
7	2.20	2.30	7.80	2.70	3.50	3.70	3.20	2.40	2.10	3.20	4.10	2.90
8	2.20	2.30	7.60	2.70	3.80	3.55	3.20	2.30	2.10	3.20	3.75	2.90
9	2.20	2.30	6.95	2.70	3.55	3.50	3.20	2.30	2.10	3.10	3.65	2.80
10	2.20	2.30	7.80	2.80	3.50	3.50	3.15	2.25	2.10	3.00	3.50	2.80
11	2.20	2.30	9.15	2.80	3.40	3.35	3.10	2.20	2.10	3.00	3.50	2.80
12	2.20	2.30	8.85	2.90	3.30	3.35	3.00	2.20	2.10	3.00	3.40	2.80
13	2.20	2.30	5.95	2.90	3.15	3.40	3.00	2.20	2.10	2.90	3.30	2.80
14	2.20	2.30	4.70	2.90	2.95	3.60	2.90	2.20	2.10	2.90	3.20	2.70
15	2.30	2.30	4.15	2.90	2.80	3.50	2.80	2.20	2.10	2.90	3.20	2.70
16	2.30	2.30	3.85	7.50	4.50	3.50	2.70	2.20	2.25	2.85	3.10	2.70
17	2.30	2.30	3.80	7.60	13.00	3.80	2.85	2.10	2.75	2.80	3.00	2.70
18	2.30	2.30	3.70	4.35	15.60	3.55	2.85	2.10	3.15	2.80	3.00	2.70
19	2.30	2.30	3.55	4.90	15.80	3.35	2.75	2.10	3.40	2.80	3.00	2.70
20	2.30	2.30	3.60	6.25	7.10	3.30	2.70	2.10	3.15	2.70	3.60	2.70
21	2.30	2.30	3.30	4.40	5.20	3.30	2.60	2.10	2.95	2.70	3.35	2.70
22	2.30	2.30	3.10	3.65	4.80	3.20	2.70	2.10	2.90	2.70	3.15	2.60
23	2.30	2.30	2.90	7.65	4.40	3.05	2.80	2.10	2.90	2.70	3.20	2.60
24	2.30	2.30	2.90	8.80	4.15	2.90	2.90	2.10	3.40	2.70	3.45	2.60
25	2.30	2.40	2.90	5.00	3.95	2.75	3.05	2.10	7.30	2.80	3.50	2.60
26	2.30	2.45	2.90	5.40	4.15	2.55	3.25	2.10	4.45	2.90	3.40	2.60
27	2.30	2.50	2.85	4.90	4.40	2.50	3.65	2.10	4.90	2.80	3.30	2.65
28	2.30	2.60	2.80	3.95	3.90	2.70	3.85	2.10	10.80	2.80	3.30	2.60
29	2.30	.....	2.80	4.05	7.20	2.90	3.65	2.10	11.70	7.50	3.30	2.70
30	2.30	.....	2.80	4.20	7.95	5.90	3.60	2.10	10.30	11.00	3.30	.....
31	2.30	.....	2.80	.....	7.35	.....	3.45	2.10	.....	10.75	.....	.....

TEXAS RIVERS.

The year 1900 was marked by an increased flow of all of the Texas rivers. The flow of the two previous years was somewhat below the average. In all of the streams from the Pecos east, and especially in that section bounded by the Pecos and Colorado rivers and by the International and Great Northern and the Southern Pacific railroads, generally known as the Edwards Plateau, the increase in the flow is marked, the discharge of the Colorado being greater than at any time during the last twelve years. All of the streams forming the system at the foot of the Edwards Plateau, namely, Barton Springs at Austin, the San Marcos at San Marcos, Comal River at New Braunfels, San Antonio River at San Antonio, Leona River at Uvalde, Los Moras Creek at Brackettville, Mud Creek in the western part of Kinney County, and the San Felipe Springs at Del Rio, have shown a decided increase in their volume. In fact, during 1900 the entire section referred to has raised the best stock of the last ten years, which means an abundance

of rain. Barton Springs more than trebled its flow of 1898, while San Antonio River, which had been dry for several years, began to flow during the latter part of 1899, and its discharge increased to such an extent that the water-power plants started up early in the year 1900. Leona River at Uvalde, which had also been dry for several years, began to flow again; Los Moras Creek shows an increase since the flood of June, 1899; and Mud Creek—dry since 1893—began to flow, making irrigation from it again possible.

BRAZOS RIVER AT WACO, TEXAS.

In September, 1898, a gage was established on the southwest bank of Brazos River at Waco. It consists of an inclined iron bar, 3 inches by 1 inch, reading from 0 to 4.3 feet, bolted to a hard pine stick 16 feet long, embedded in cement in the sloping limestone of the bank, flush with the surface, on which are painted the graduations above 4.3 feet. The gage is inclined at an angle of $\sin^{-1}\frac{10}{54}$ to the horizontal. Three bench marks have been established. The first is on the lowest water table on the southwest pier of the suspension bridge, and is marked "U. S. G. S. 44.33 B. M." The hydrant at the corner of First and Austin streets is at an elevation (by gage) of 43.32 feet, while the top of the rail of the San Antonio and Aransas Pass Railroad, a few feet from the hydrant, is at an elevation of 41.12 feet. During 1900 fourteen measurements of the flow were made. The bed of the river is shifting sand, and nearly every freshet modifies the cross section, so that at the same gage heights the river sometimes flows in one channel, sometimes in two channels, under the suspension bridge from which the measurements are made. In order, therefore, to plot a rating curve, the measurements for 1900 will have to be arranged in a January to July group and an August to December group, as the channel was modified. So far as known, the minimum flow of Brazos River at Waco occurred on December 26, 1898, the discharge being 141 second-feet.

The United States Weather Bureau commenced observations of the flow of the river at Waco on August 1, 1900, on a gage painted on the southeast portion of the pier of the St. Louis and Southern Railway bridge nearest the center of the river. Graduations are in feet and tenths, and extend from zero to 37 feet. The bench mark is the top of the rail in front of the St. Louis and Southern Railway station at Waco. It is 41.5 feet above the zero of the gage, and, according to the levels of the railroad company, it is 410 feet above sea level. During the year this gage was for many weeks surrounded by a sand bank, and on two occasions the edge of the water was 60 feet distant from the gage.

During 1900 the following measurements of discharge were made:

Discharge measurements of Brazos River at Waco, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 31	4.10	1,341	December 19	3.50	552
February 22	3.30	658	December 20	3.40	512
March 13	3.10	540	December 28	3.20	411
August 28	3.35	399	December 29	3.18	403
August 29	3.30	373	December 30	3.17	397
September 7	4.70	1,323	December 31	3.16	394
September 8	4.60	1,197			

Daily gage height, in feet, of Brazos River at Waco, Texas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.45	4.00	3.10	4.05	11.00	12.35	4.65	6.25	3.45	14.35	9.90	3.90
2	4.30	3.90	3.10	4.00	11.40	14.30	4.60	6.60	3.40	10.95	6.20	3.80
3	4.25	3.90	3.00	4.00	11.85	12.30	4.60	6.00	3.25	8.50	5.45	3.80
4	4.25	3.90	3.00	3.85	10.20	10.25	4.65	7.35	3.20	7.40	5.80	3.80
5	4.15	3.80	3.00	3.75	9.55	9.00	4.85	6.60	3.15	6.90	5.85	3.70
6	4.25	3.80	3.00	3.70	8.90	8.35	4.75	5.90	3.10	6.80	6.10	3.60
7	4.30	3.80	3.75	14.50	8.40	7.85	4.65	5.45	4.45	6.50	5.60	3.60
8	4.20	3.80	3.95	22.90	8.05	7.70	4.60	5.45	4.40	6.05	5.55	3.60
9	5.90	3.85	3.45	20.90	7.50	7.20	4.55	6.40	4.50	5.85	5.05	3.60
10	5.85	3.95	3.35	19.70	7.10	6.90	4.50	5.90	9.10	5.75	4.85	3.60
11	9.15	3.70	3.25	11.50	6.90	6.55	4.50	5.65	9.45	5.65	4.60	3.60
12	7.90	3.80	3.10	9.25	6.60	6.55	4.70	5.95	8.35	5.20	4.50	3.65
13	6.15	3.80	3.10	12.00	6.50	6.40	4.75	5.50	9.15	5.10	4.50	3.65
14	5.70	3.75	3.10	9.60	6.20	6.20	4.60	5.20	8.20	5.05	4.40	3.65
15	5.40	3.60	3.15	8.90	6.45	6.05	4.65	6.55	7.45	4.90	4.35	3.70
16	5.45	3.55	3.20	8.20	8.20	5.75	9.35	6.70	7.05	4.75	4.30	3.60
17	5.20	3.50	3.20	8.00	7.50	5.50	7.70	5.95	6.45	4.55	4.20	3.60
18	5.00	3.50	3.20	7.30	6.80	5.40	6.05	5.50	6.20	4.50	4.20	3.55
19	4.90	3.45	3.15	7.00	6.35	5.30	6.80	5.25	5.70	4.40	4.20	3.50
20	4.70	3.40	3.10	6.55	6.25	5.15	6.75	5.05	5.20	4.35	4.15	3.40
21	4.70	3.35	3.05	6.80	7.00	5.25	5.95	5.00	5.00	5.25	4.10	3.40
22	4.60	3.30	3.00	6.60	7.20	5.45	5.60	4.45	10.25	8.20	4.15	3.40
23	4.50	3.30	3.75	6.80	6.70	5.10	4.75	3.85	15.20	7.15	4.20	3.40
24	4.45	3.20	6.25	6.65	6.65	4.60	5.50	3.45	19.65	7.85	4.05	3.40
25	4.30	3.20	5.60	6.70	7.25	5.15	7.15	3.60	21.15	6.95	3.95	3.30
26	4.25	3.20	5.00	6.00	7.50	5.05	9.05	3.55	22.30	7.10	3.90	3.30
27	4.20	3.20	5.10	8.05	9.55	4.95	8.30	3.50	23.95	6.45	3.90	3.30
28	4.10	3.10	4.85	12.00	8.00	4.80	7.45	3.45	25.70	5.90	4.05	3.30
29	4.10	.....	4.65	12.00	7.45	4.75	7.40	3.40	22.95	6.00	4.10	3.20
30	4.10	.....	4.35	13.80	12.70	4.70	6.45	3.50	17.00	5.55	3.90	3.20
31	4.05	.....	4.15	.....	16.30	.....	6.15	3.60	.....	8.80	.....	3.20

LEON RIVER, TEXAS.

Leon River rises in Eastland County, Texas, and flows through Comanche, Hamilton, Coryell, and Bell counties, emptying into Little River, a tributary of Brazos River. A short distance above Belton it receives the waters of Cowhouse Creek. The flow of Leon River is utilized at Belton by the electric-light plant. The dam, which was built in 1894, is of wood, built up in a compact mass. The downstream face has a vertical fall of 7 feet, and then terminates in a slightly inclined apron, which serves to break the fall of the water and carry it off without damage to the lower toe. The length of the dam is 160 feet, the total height above bed rock 12 feet. The bulkheads are built up to a level above the banks, and constitute the piers of one of the highway bridges across the river. The water is taken

from the lake above the dam by a flume on the west side of the river. This flume rests on a well-protected framework, which is boarded up on the river side. The power house is about 100 feet below the dam, where a fall of 11 feet is obtained. The river rarely ceases to flow at Belton, but during the fall it is so low that it does not furnish sufficient power to supply the electric lights for the town. On an average the river furnishes sufficient power for two-thirds of the year, and an auxiliary steam plant is used to tide over the stages of low water. The power required by the electric-light plant is from 150 to 200 horsepower. On December 19, 1900, the flow of the river was measured by Thomas U. Taylor at a point halfway between the dam and the bridge of the Gulf, Colorado and Santa Fe Railroad, about 75 yards below the dam, and a flow of 165 second-feet was found. The measurement was made in the afternoon, and about 6 inches of water was flowing over the dam.

LAMPASAS RIVER, TEXAS.

The junction of Lampasas and Leon rivers forms Little River, which flows into Brazos River. The Sulphur Fork of Lampasas River rises in the city of Lampasas, and is formed by two springs, the Hancock and the Hanna. The Hancock Spring is about 1 mile from the court-house, and its flow on December 18, 1900, as measured by Thomas U. Taylor, was 10.3 second-feet. The measurement was made just below the ford, and about 400 feet below the bath house at the spring. The dam of the electric-light plant, which is a little more than a half mile below the spring, backs the water up to within 200 yards of the spring. The flow of the spring is stated by citizens to be reliably constant. The Hanna Spring is about a fourth of a mile from the court-house, and almost on the opposite side of the town. It rises in a large artificial pool, 60 feet in diameter, constructed of stone and cement. The water, which is strongly impregnated with sulphur, flows out of the pool over an inclined apron, and can be diverted to the large bath house near. The stream formed by the spring has been diverted from its original channel, and is conveyed underground a distance of about 200 yards, although at certain places it is visible through the boxes, the sides of which project above the surface of the ground. At one of the boxes the flow of the spring on December 19, 1900, was found to be 4 second-feet. The waters of these springs are utilized by various power plants.

There are three dams across the Lampasas within 1½ miles of the city of Lampasas. The electric-light plant is in the suburbs of the city. It has a stone dam 14 feet high and 160 feet long. The water is conveyed, by a race nearly 300 yards long, to the power house, where a fall of 14 feet is obtained. The waters above this stone dam are held back during the day, being used only at night, and the lake above the dam fills and the water begins to flow over the dam shortly after midday. A judicious use of flashboards would render more

power available. With an efficiency of 75 per cent a flow of 1 cubic foot of water would give a continuous horsepower of 1.2, or a total of 12 horsepower if used continuously, or a total of 28.8 horsepower if used for only ten hours during the day and held back for fourteen hours. An auxiliary steam engine is used at the power plant. The second dam is about three-fourths of a mile below the stone dam. It is an old-fashioned wooden structure 120 feet long, and gives a fall of 11 feet. The triangular frame bents are constructed with the inclined braces upstream. To these braces sheeting is nailed, which forms the upstream face of the dam. With a good hydraulic wheel 1 cubic foot of flow should give 1 horsepower at this dam. The power here is used by the Donovan flour mill, but the flow of the stream is under the control of the upper dam to such an extent that a gasoline engine is used as an auxiliary power. The lower dam, which is also of wood, is about three-fourths of a mile below the Donovan dam, and has a fall of about 10 feet.

COLORADO RIVER AT AUSTIN, TEXAS.

During 1900 the flow of Colorado River of Texas was the largest during the last twelve years. The flood of April 7, which carried away the great masonry dam at Austin, was general over southwest Texas, but its only disaster was limited to the demolition of that structure. A full discussion of the flow of the river will be found in Water-Supply Paper No. 40. From measurements made in 1899 it was demonstrated that the minimum flow of the river at the head of the lake created by the Austin dam (the so-called Lake McDonald) was less than 200 second-feet, from which should be deducted the evaporation from the 3 square miles of lake surface, making the flow at the forebay of the dam still smaller. The supposed minimum flow of 1,000 second-feet, upon which the construction of the dam and its allied enterprises was predicated, was one of the greatest overestimates known to American engineering practice. With a fall of 62 feet, the flow of the river at low stages could not develop even 900 horsepower, while 5,227 horsepower had been counted upon for minimum stages of the river.

Records of the depth of water on the crest of the dam at Austin were kept from September 1, 1895, to January 1, 1900, and the maximum and average depths of water on the crest as recorded by the gage were as follows:

Depths of water on crest of Austin dam.

Year.	Maximum depth.	Average depth.
	Feet.	*Feet.*
1896	2.60	0.496
1897	2.20	.422
1898	4.20	.280
1899	9.80	.412
Average for 4 years		.4025

On account of the inequalities of the crest line of the dam, all depths must be increased by 0.009 foot to get an average for the whole spillway of 1,091 feet.

Experiments with an electric current meter were made during January and March of 1900, to determine the coefficient C in the weir formula $Q = Cl\,H^{\frac{3}{2}}$. The results obtained indicate that for the Austin dam C was nearly 3.09, the theoretical coefficient used by Frizell. Substituting this value of C and the length of l (1,091 feet), we get $Q = 3.371\ H^{\frac{3}{2}}$.

The average flow through the penstocks for the same years (1896, 1897, 1898, and 1899) was about 250 second-feet. The following table gives the maximum and average daily discharge, in second-feet, including the flow through the penstocks:

Discharge of Colorado River at Austin dam.

Year.	Gage height.		Discharge.		
	Maximum.	Average.	Maximum.	Minimum.	Average.
	Feet.	*Feet.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
1896	2.60	0.505	14,100	.....	1,460
1897	2.20	.431	11,000	200	1,200
1898	4.20	.326	29,000	210	1,880
1899	9.80	.421	103,400	134	1,170

The average discharge for the four years is 1,160 second-feet.

Prior to the flood of April 7, 1900, the discharge of the river at the station below the dam was at low stages absolutely under the control of the turbines at the power house at the dam, and measurements made opposite the city, at the station between the two bridges, did not give the unobstructed flow of the river. Since the destruction of the dam measurements have been made at the station about a fourth of a mile above the highway bridge on Congress avenue. The station is described in Water-Supply Paper No. 37, page 274.

During 1900 the following measurements were made by Thomas U. Taylor:

Discharge measurements of Colorado River at Austin, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 7	33.50	122,000	September 13	2.46	1,398
August 24	2.40	1,160	September 17	2.35	1,107
August 25	2.35	990	September 18	2.25	935
August 27	2.21	793	September 19	2.19	895
August 30	2.13	747	September 20	2.14	806
September 1	2.40	1,198	September 21	2.10	739
September 4	2.45	1,306	December 22	2.90	2,109

Daily gage height, in feet, of Colorado River at Austin, Texas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.60	2.10	2.70	4.00	4.70	2.30	3.00	2.35	6.20	4.15	3.05
2	2.40	2.50	2.20	2.80	4.50	5.00	2.30	3.05	2.30	5.70	3.90	3.00
3	2.40	2.50	2.50	2.90	5.00	5.50	2.30	3.10	2.30	5.30	7.25	3.00
4	2.50	2.40	2.60	3.10	10.00	5.00	2.35	3.60	2.45	5.05	6.00	3.00
5	2.40	2.40	2.50	3.40	11.60	4.80	2.35	4.90	2.40	4.70	4.55	3.00
6	2.40	2.40	2.50	5.60	6.00	4.10	2.45	4.30	2.40	4.45	4.15	3.00
7	2.50	2.30	2.40	32.70	4.50	3.70	2.35	4.05	2.35	4.40	3.80	2.90
8	2.40	2.30	2.30	14.70	4.10	3.60	2.30	4.75	2.30	4.25	3.65	2.90
9	2.60	2.20	2.20	10.60	5.50	3.50	2.30	5.60	2.40	4.05	3.50	2.90
10	2.50	2.20	2.20	10.40	4.90	3.20	2.20	4.75	2.40	3.95	3.40	2.90
11	2.50	2.10	2.10	9.70	4.40	3.10	2.20	4.35	2.50	3.90	3.30	2.90
12	2.40	2.00	2.20	9.40	4.50	3.00	2.40	4.15	2.60	3.80	3.25	2.90
13	2.60	2.00	2.10	9.30	4.10	3.00	2.30	4.40	2.50	3.70	3.20	3.00
14	2.70	1.90	2.00	9.00	4.20	3.10	2.25	3.65	3.35	3.60	3.20	3.00
15	3.00	1.90	2.00	8.60	4.50	3.00	2.40	3.30	2.75	3.60	3.20	3.00
16	2.90	2.00	2.10	8.50	7.00	2.80	2.40	3.15	2.50	3.60	3.20	3.05
17	2.80	2.10	2.00	8.40	7.00	2.80	8.77	3.05	2.35	3.50	3.20	3.10
18	2.70	2.00	2.00	8.20	5.50	2.70	5.40	2.90	2.25	3.50	3.10	3.10
19	2.70	2.00	2.10	8.10	4.90	2.60	8.15	2.85	2.20	3.40	3.10	3.00
20	2.60	1.90	2.30	8.00	4.80	2.70	9.40	2.70	2.10	3.40	3.10	2.95
21	2.60	1.90	2.30	7.70	4.50	2.70	6.75	2.60	2.10	3.55	3.10	2.90
22	2.50	1.80	2.40	7.60	4.40	2.60	4.75	2.50	2.10	4.60	3.10	2.90
23	2.50	1.90	2.50	7.60	4.20	2.50	3.95	2.45	2.45	4.70	3.10	2.90
24	2.40	1.90	2.50	7.40	5.20	2.50	3.55	2.40	7.40	4.70	4.85	2.90
25	2.40	2.00	2.60	7.30	4.50	2.50	3.25	2.35	19.50	5.40	5.60	2.80
26	2.40	2.10	2.80	6.00	4.80	2.50	3.30	2.30	17.60	4.65	3.60	2.80
27	2.50	2.10	2.90	5.60	4.90	2.40	3.05	2.20	21.95	4.25	3.35	2.80
28	2.50	2.20	3.00	4.90	6.00	2.40	3.00	2.20	21.30	3.95	3.20	2.80
29	2.60	.....	2.90	4.60	6.00	2.45	3.30	2.20	11.90	3.75	3.20	2.80
30	2.70	.....	2.80	4.30	5.00	2.30	3.35	2.20	7.05	4.40	3.10	2.80
31	2.50	.....	2.70	.....	5.00	.....	3.15	2.65	.....	5.20	.....	2.80

BARTON SPRINGS, TEXAS.

These springs are about 2 miles southwest of the court-house in the city of Austin. Their flow was formerly so great that two mills were operated on the right or southwest bank of the creek formed by them. The upper springs come out of several fissures or faults in the limestone rock on the right side of the creek and supply probably half of the total flow. Another spring is on the left side of the creek, a short distance below the upper springs, and its flow has been unfailing. The third spring is on the right side of the creek, and it was formerly utilized to run the Walsh mill. It had been dry for several years, but early in 1900 it began to flow again. The flow of the creek to which the springs give rise, and which empties into Colorado River at Austin, has responded sympathetically to the rainfall in the Edwards Plateau. In 1894 and 1895 C. C. Babb made measurements of its flow and found a discharge of 17 and 25 second-feet, respectively. In 1898 Thomas U. Taylor measured the flow and found the following discharges: March 26, 20 second-feet; May 3, 30 second-feet. On August 31, 1900, the flow had increased to 69 second-feet, and on December 21, 1900, it was found to be 32.5 second-feet.

BLANCO RIVER, TEXAS.

Blanco River rises in Kendall County, flows easterly for 60 miles, and then turns southeast and flows into San Marcos River 4 miles below San Marcos. In dry years its flow ceases and water stands in

pools, but in years of average rainfall it has a small flow, except in time of flood. On December 24, 1900, it was measured at Ware's ford, 2 miles east of San Marcos, by Thomas U. Taylor, and a flow of 15 second-feet was found. On the same date San Marcos River was measured by Mr. Taylor at the Westerfield ford, and a discharge of 157 second-feet was found.

COMAL RIVER, TEXAS.

The mountains of the Edwards Plateau terminate about a mile northwest of New Braunfels, and from the fissures at the foot of the bluffs the celebrated springs that form Comal River gush forth. The waters have been used for power since 1860, but it is only since 1880 that systematic methods have been used. At present the waters are all used by the Landa and Faust mills. The Landa mill is about a half mile from the main springs, and is located near the banks of a dry branch of Comal River. A gravel dam deflects a large percentage of the water from Comal Springs Creek into the Landa mill race. The Faust mill is a half mile below the Landa mill, and is north of the court-house at New Braunfels. Comal River is the most unique, picturesque, and reliable stream in Texas. Its flow is reasonably uniform, and it has a fall of 43 feet in its length of 2 miles. From the surface of Lake Comal (formed by the gravel dam referred to) to the surface of Landa's mill pond there is a fall of 2 feet; at Landa's mill there is a fall of 22 feet; from the tailrace of Landa's mill to the surface of Faust Lake there is a fall of 3 feet; at the Faust dam there is a fall of 8 feet; and from the latter dam to the Guadalupe there is a fall of nearly 10 feet. In 1882 the flow was measured, independently, by two civil engineers, by the use of floats, and each found a discharge of 375 second-feet. From that time until 1899 there was a gradual decrease of flow, the minimum, from the best evidence obtainable, being 290 second-feet. Early in 1900, however, the flow of Comal River, like that of all of its sister springs in the Edwards Plateau, increased to its former volume of twenty years ago.

On December 25, 1900, when it was certain that the power plants would be idle, Thomas U. Taylor visited Comal River, in order to obtain a measurement of the flow that would be uninfluenced by the drafts for power purposes. The sections selected were on the Landa raceway, about 50 yards below the gravel dam, and on Comal Springs Creek, 275 yards below the dam. The joint discharge was found to be 374 second-feet, the full capacity of the springs. On December 26 the flow was again measured at the same section, with all of the mills running, and a discharge of 272.6 second-feet was found. The level of the water in the race at the section selected was not affected by shutting off the power.

Records have been kept of the flow of the river over a weir in the

lower or Clements dam, from which the following calculations of discharge were made:

Discharge measurements of Comal River over weir at Clements dam, 1900.

	Sec.-ft.
January 20	301
February 4	283
February 22	305
March 8	335
March 13	326
March 18	326
April 1	324
April 15	329
May 13	433
June 5	372

Guadalupe River was measured September 20, 1900, by Thomas U. Taylor, at the railroad bridge at New Braunfels, and a discharge of 653 second-feet was fonnd.

SAN ANTONIO RIVER, TEXAS.

San Antonio River rises about 3 miles north of the mission of San Fernando, the geographic center of the city of San Antonio. To better control and utilize the waters of the river, two canals, an upper and a lower, were constructed in 1878 and 1881, respectively. A power house was built on each canal, and they are known as the upper and lower power houses. The fall at the upper power house is about 7 feet, that at the lower power house 12 feet, while at Guenther's upper and lower mills the fall is 3.5 feet and 6 feet, respectively. In 1896 the flow of San Antonio Springs became so low that the mills were abandoned. Previous to this, in 1895, an auxiliary steam plant of 130 horsepower was put in at the lower power house. The water at these power stations was pumped from artesian wells—one 12-inch at the upper station and one 12-inch and three 8-inch at the lower station. In 1891 a steam and electric power plant was constructed on the banks of the river, near Commerce street, where there are four 8-inch wells and three 12-inch wells.

In December, 1895, the flow of San Antonio River at the head gate of the lower canal was measured by C. C. Babb, and a discharge of 34.3 second-feet was found, to which should be added 1.2 second-feet for the leakage through the dam, and 4 second-feet for the diversion through the upper labor ditch, making a total of nearly 40 second-feet. On the same date Mr. Babb measured the flow of San Pedro Springs and found a discharge of 9 second-feet. On November 30, 1896, Mr. Babb again made measurements and found the discharge of San Antonio River and San Pedro Springs to be 29 second-feet and 11.7 second-feet, respectively. On December 30, 1897, the flow of San Antonio River was measured by Thomas

U. Taylor at the footbridge leading from the hot wells to San Jose Mission, and a discharge of 11 second-feet was found. In March, 1898, it was again measured at the same place and a discharge of 9 second-feet was found, and in June, 1899, the discharge was 10 second-feet, all of which came from San Pedro Springs.

An indication of the stage of the underground water can be obtained from the record of the water level in the standpipes at the waterworks on Commerce street and at the upper power house. These standpipes are connected to the artesian wells. The standpipe at the Commerce street works is about 50 feet high. Following is a record of the heights of the water in this standpipe. The datum at this station is the bottom of the standpipe.

Heights of water in Commerce street standpipe.

Date.	Height.	Date.	Height.
	Feet.		*Feet.*
May, 1893	42.10	May 1, 1900	44.10
December 6, 1897	33.80	May 5, 1900	45.10
April, 1898	31.60	May 9, 1900	46.20
April 29, 1900	43.00	May 22, 1900	47.10

The record of the standpipe at the lower power house is as follows:

Heights of water in standpipe at lower power house.

Date.	Height.	Date.	Height.
1900.	*Feet.*	1900.	*Feet.*
January 1	1.8	July 1	14.65
February 1	6.76	August 1	12.67
March 1	13.76	September 8	12.10
April 1	13.77	October 1	11.47
May 1	15.57	November 1	11.38
May 24	18.74	December 1	10.51
June 1	17.99		

It is well to note that the dates of low and flush water at San Antonio correspond exactly with those at Uvalde.

During the latter part of the year 1899 the river revived, and in 1900 the following measurements were made by Thomas U. Taylor:

Discharge measurements of San Antonio River and its tributaries.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-ft.*
September 12	San Antonio River	At hot wells	125.0
September 18	do	do	124.2
September 19	San Pedro Creek	Near street-car crossing about 100 yards below lower or large pool.	1.6
Do	San Pedro ditch	do	7.0

The last two measurements were made early in the morning, in order to ascertain the free flow of the springs unmodified by the

dams. At the time of measurement the water had been flowing uninterruptedly over the two small dams at the head of the ditch and the river for from twelve to fourteen hours. There is a head gate on the river which can be raised and lowered at will in order to flush or scour out the pools.

On September 19, 1900, the flow at the head gate of the lower canal, where Mr. Babb measured it in 1895, was again measured. The water at this point flows under an arched stone conduit of 20 feet span. A wooden strip is embedded in the cement floor of the canal. The depth of the water over the wooden strip was 38½ inches, and a flow of 94 second-feet was found. On November 29, 1900, the depth of water was 28.8 inches, and a flow of 59 second-feet was found.

LEONA RIVER AT UVALDE, TEXAS.

The behavior of this river has been so irregular for several years that a recapitulation of some of the data heretofore published is of special interest in connection with the new data presented herewith.

Leona Spring is situated in the suburbs of Uvalde. It was dry in 1885, but soon after it revived and continued to flow until 1893, when it ceased flowing and has been dry since. In 1893 a pumping station was located on the banks near the spring, but when the spring failed the pumping plant was transferred to its present location, within 150 yards of the court-house. At the new station a pit 15 feet by 15 feet was excavated to a depth of 24 feet, and the pumps were placed in its bottom, a well 4 feet by 7 feet having been sunk in the bottom of the pit to a depth of 16 feet, or to the 40-foot level below the ground surface, out of which water was pumped to a standpipe. At first the water in this well rose to within 35 feet of the surface, but in December, 1897, it was noticed that the supply was failing. In May, 1898, the supply continuing to fail, a second pit 10 feet by 10 feet by 9 feet deep was excavated on the southwest side of the first or main pit, and a well was sunk to a depth of 63 feet below the surface of the ground. The pumps were then placed in the new pit, making their position about 33 feet below the surface. In January, 1899, the water level had fallen so low that it was necessary to bore three wells in the pump well to a depth of 30 to 35 feet, reaching a total depth of 98 feet below the ground surface. In June, 1899, after the heavy rains over southwest Texas, known as the Brackett flood, the water was standing at about the 93-foot level and was slowly rising. On September 16, 1900, the water had risen to within 2 feet of the pumps, or to the 35-foot level; that is, the water had risen about 58 feet in fifteen months, or nearly 4 feet a month, and on December 1, 1900, it had reached the pumps and arrangements were made to raise them. Accurate measurements during September, 1900, showed that the water in the wells was at that time rising at the rate of 4 inches a month.

Between Leona Spring and the brickyard crossing on the road from Uvalde to Pearsall there are several small springs, the largest being Mulberry Spring, which during the early part of 1900 was flowing; in September, 1900, its flow had ceased, and on December 1, 1900, it had a flow of about 1 second-foot. In 1895 C. C. Babb found a discharge at the brickyard crossing of 11 second-feet; but when the spring was visited by Thomas U. Taylor in June, 1899, the river at the ford was dry, and there was no water flowing between Uvalde and Fort Inge, 4 miles below Uvalde. On September 17, 1900, Mr. Taylor found a flow at the brickyard crossing of 5 second-feet.

NUECES RIVER, TEXAS.

The two main forks of Nueces River rise in Edwards County, Texas, and flow south through the rugged mountains of the Edwards Plateau, uniting about 14 miles from Uvalde and about 6 miles above the crossing of the Southern Pacific Railroad. On their way through the mountains both branches are fed by springs, and there is perpetually running water in the streams, which begin to flow about 12 miles south of Rock Springs and continue to flow until their junction at the foot of the Edwards Plateau. At about the junction of the streams the usual flow sinks into gravel beds, occasionally reappearing in big, clear pools at points where the gravel has been washed off from the solid bed-rock bottom. Four or 5 miles below the Southern Pacific Railroad bridge flowing water again appears, the stream along its lowland course being fed by numerous springs. On September 17, 1900, Thomas U. Taylor made a measurement of the flow about 5 miles below the railroad crossing, and a discharge of 18 second-feet was found.

There are a few irrigated farms along the Nueces. Mr. J. H. Ethridge, of Montell, Uvalde County, Texas, is the owner of the Casa Blanca irrigation and mill ditch, which was constructed in 1893. This ditch is 2½ miles long, 7 feet deep for the first half mile, and 2 to 3 feet deep the rest of the way. Water is diverted from Nueces River by means of a dam of loose rock which raises the level of the water in the river. Six miles below the Southern Pacific Railroad bridge Patrick Dolan has introduced a 15-horsepower gasoline engine with which he irrigates his orchards and gardens, pumping water from the river. The cost of the outfit was $735, but Mr. Dolan finds that with the present high price of gasoline (18 cents a gallon) irrigation by that means is too costly. His experience is that with gasoline at 12 cents a gallon irrigation by pumping can be made to pay in that section of the country. At Cotulla Mr. George Copp uses a duplex pump having a 6-inch suction and a 4-inch discharge, with a 12-horsepower steam engine. He irrigates 100 acres and raises a very fine quality of Bermuda onions for a spring crop and tomatoes for a fall crop.

LOS MORAS CREEK, TEXAS.

Los Moras Creek rises at Brackettville, near Fort Clark, in Kinney County, Texas, about 7 miles north of the Southern Pacific Railroad. On December 24, 1895, the flow was measured by C. C. Babb, about 300 yards below the dam, under the footbridge leading from the town to the military post, and a discharge of 21 second-feet was found. On June 30, 1899, it was measured at Mulligans Bend, about a fourth of a mile east of the court-house at Brackettville, by Thomas U. Taylor, and a flow of 60 second-feet was found; and on September 13, 1900, a flow of 51 second-feet was found at the same place. The increase in the flow was due probably to the increased rainfall along the Southern Pacific, which skirts the foothills of the Edwards Plateau.

On June 14, 1898, occurred the biggest flood in the history of Kinney County, and extending over the country from Spofford to Del Rio. The Los Moras Mountains, about 4 miles a little east of north from Brackett, form a crescent in which Brackett and Fort Clark are situated, and all of the depressions and dry streams from these mountains converge toward the former place. From 11.30 p. m. on June 13, 1899, to about 6 a. m. on June 14, a total rainfall of 18 inches fell at Brackett and in the Los Moras Mountains. By 5 a. m. of the latter day the flood was upon the town, standing 7.4 feet deep in the court-house, 6.7 feet in the store of Roach & Company, 9.6 feet in the Terrell House, while in the street in front of the hotel it was 12.1 feet deep. The main channel of Los Moras Creek, between Brackett and Fort Clark, was at flood height, while the draw that runs into the creek at Mulligans Bend was flooded to the depth of 30 feet. The lowlands between Spofford and Brackett were flooded for miles, and the tracks of the Southern Pacific Railroad were wrenched up and twisted like ribbons.

In March, 1900, another flood occurred at Brackett, but the damage was slight, the flood being more than 9.5 feet below the height attained by the flood of the previous June. Former floods occurred on May 28, 1880, and on October 1, 1881. During the 1880 flood the water flooded the stores in Brackett and did considerable damage. On October 1, 1881, there was a rainfall of 14.2 inches in a few hours, and by 3 a. m. the town was flooded, and much damage was done to homes and to business houses.

The waters of Los Moras Creek are used for irrigating farms and gardens within 10 miles of Brackett. The ditch nearest to Brackett is on the west side of the creek. It is used by the Seminole Negro Indians on the Fort Clark Reservation, and is therefore the property of the Government. It is about 1 mile long, 5 feet wide, and 1 foot deep. The Indelkofer-Gilder ditch, also on the west side of the creek, diverts water 1 mile below the intake of the Seminole ditch. It is 600 feet long, 4 feet wide, and 1 foot deep. The McGovern ditch diverts water from the east side of the creek a short distance above the intake of

the Indelkofer-Gilder ditch. It is 600 yards long, 5 feet wide, and 1 foot deep. About 6 miles below Brackett two ditches—the Smith and the Stratton—divert water, one from the west and the other from the east side of the creek. The Smith ditch is 600 feet long, 4 feet wide, and 1 foot deep. The Stratton ditch is 3 miles long, 8 feet wide, and 1 foot deep, and irrigates a hay farm below the Southern Pacific Railroad.

PINTO CREEK, TEXAS.

Pinto Creek rises in Kinney County, Texas, and is about halfway between Brackett and Del Rio. At the crossing of the Southern Pacific Railroad it has a sluggish flow, but the geologic formations and topography throughout its course are such as to make it susceptible to sudden and great rises. Its flow was measured on September 15, 1900, by Thomas U. Taylor, at the crossing of the Southern Pacific Railroad, and a discharge of 38 second-feet was found. The waters of the Pinto have been used for irrigation, the Lower Pinto Irrigation Company having utilized those near the Rio Grande. Their ditch, which was constructed in 1875, was 10 miles long, 6 feet wide, and 1 foot deep, and crossed the Pinto by means, first, of a siphon flume, and then by a trestle flume, but these were so difficult to maintain, on account of the sudden floods to which the creek is subject, that the company was forced to abandon the system.

MUD CREEK, TEXAS.

Mud Creek is between Pinto and Sycamore creeks, in Kinney County. Its source is about 6 miles north of Amanda, on the Southern Pacific Railroad. The stream is formed and fed by springs, but its flow is not reliable. From 1893 to the latter part of 1899 the creek was practically dry, but after the Brackett flood the flow revived, and by the spring of 1900 there was sufficient water in the creek to supply the irrigation systems, all of which are above the Southern Pacific Railroad. The ditch of the Mud Creek Irrigation and Agricultural Company diverts water about 3 miles above the railroad, and during the season of 1900 about 400 acres were irrigated by it.

SAN FELIPE SPRINGS, TEXAS.

San Felipe Creek has its source in four large springs, the upper one being 2 miles above the railroad bridge near the town of Del Rio, the others being within about 200 yards of the bridge. Measurements at the former place in 1895 are described in Bulletin of the United States Geological Survey No. 140, page 85. Measurements made in 1899 are described in Water-Supply Paper No. 37, page 277. On September 15, 1900, Thomas U. Taylor measured the outflow from these springs and found a discharge of 99 second-feet, and Madre ditch, which diverts water just below the lower spring, was found to be carrying

50 second-feet. This makes the total flow of the springs at that time 149 second-feet.

RIO GRANDE.

The Rio Grande and its tributaries drain the mountainous area to the south and east of the Continental Divide in southwestern Colorado, the principal streams flowing from the east side of the Needle Mountains and from the south and east side of the San Juan Range. Important streams also flow from the La Garita Mountains in Saguache and Mineral counties. The main stream flows in an easterly direction for about 75 miles, receiving numerous tributaries from the mountainous region through which it passes. At the town of Del Norte the valley widens into what is known as San Luis Valley, and thence the stream flows in a southeasterly and southerly direction for about 75 miles more, to a point about 20 miles southeast of Antonito, where it crosses the State line. Below Del Norte few streams of importance flow into the river, for nearly all of those that issue from the mountains lose their waters in the plains before they reach the main stream. This is particularly true of the drainage north and east of the river, from the Cochetopa Hills and the Sangre de Cristo Mountains. Although the streams flowing from them are numerous and carry large volumes of water, yet they furnish no source of supply to the Rio Grande itself, all the water being lost either in the sands or in broad, shallow lakes, until Trinchera Creek, flowing through the Costilla land grant, is reached. This stream, although usually dry, furnishes a supply at different seasons of the year. On the south and west side of the river, however, many important streams flow from the mountains, which in their higher stages carry large volumes of water to the Rio Grande. Among these are the Alamosa, La Jara, Conejos, and other creeks of lesser importance. The supply from these streams also is mostly used during the summer time, so that after the flood stages are past little water flows from any of these sources into the Rio Grande. A similar condition of affairs exists in the Rio Grande itself, as most of the water is used in the upper part of the valley, and in the late summer very little passes Alamosa, below which place there are few irrigating canals. During the flood stages, however, great volumes of water flow from the Rio Grande and from several of its tributaries, which might be stored and used for the extension of the irrigated area. Farming is carried on extensively among the upper valleys of several of the streams issuing from the mountains to the north and east of San Luis Valley, but no measurements have been made upon any of these streams.

The study of seepage and return waters resulting from irrigation furnishes an interesting problem in this valley, which Prof. L. G. Carpenter, of Fort Collins, has undertaken to study.

But three stations have been maintained in San Luis Valley, namely, at Del Norte and at the State line, on the main Rio Grande, and about 10 miles west of Antonito, on Conejos River.

RIO GRANDE NEAR DEL NORTE, COLORADO.

This station is about 2 miles west of the town of Del Norte, above the main canal taking water from the Rio Grande. Continuous records have been kept here since the fall of 1889. The gage rod is an inclined 2-inch by 6-inch plank fastened to a post driven into the right bank of the river. On June 16, 1900, the gage rod was connected with an iron bench mark of the United States Geological Survey, set in the ground about 25 feet south of the rod, the zero of the rod being 9.25 feet below the bench mark. Gagings are made by means of a car which travels across the river along a steel cable, the distance being marked on a tag wire. The channel is excellent, the water, although falling rapidly, seldom scouring, and the bed, therefore, remaining practically the same from year to year. The bed of the channel is covered with small bowlders and the sides, although not high, have never been known to overflow. The observer is J. S. Regan, who has kept the records regularly ever since the station was established.

A description of this station was published in Water-Supply Paper No. 37, page 277. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 256.

During 1900 the following measurements were made by A. L. Fellows:

March 30: Gage height, 1.54 feet; discharge, 346 second-feet.
May 12: Gage height, 3.84 feet; discharge, 2,441 second-feet.
June 16: Gage height, 3.66 feet; discharge, 2,382 second-feet.
August 18: Gage height, 1.34 feet; discharge, 221 second-feet.

Daily gage height, in feet, of Rio Grande near Del Norte, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				1.58	1.86	5.76	2.42	1.42	1.28	1.58	1.50	1.56
2												
3		2.50	1.84	1.62	1.94	5.26	2.30	1.40	1.32	1.60	1.50	
4												
5				1.66	2.18	4.90	2.26	1.48	1.40	1.56	1.46	
6	2.08											
7				1.70	2.50	4.76	2.08	1.50	1.36	1.54	1.40	
8												a 2.18
9				1.56	2.92	4.40	2.00	1.42	1.60	1.54	1.44	
10		2.46	1.62									
11				1.52	3.82	4.12	1.94	1.40	1.46	1.52	1.32	
12												
13	2.16			1.58	3.78	3.86	1.86	1.36	1.38	1.50	1.36	
14												
15				1.60	3.64	3.54	1.78	1.32	1.32	1.52	1.30	a 2.38
16												
17		2.58	1.58	1.64	4.52	3.68	1.70	1.32	1.32	1.52	1.32	
18												
19				1.62	4.80	3.32	1.62	1.32	1.30	1.50	1.36	
20	2.14											
21				1.76	4.20	3.18	1.64	1.34	1.30	1.52	1.32	
22												b 2.26
23				1.60	4.36	3.10	1.62	1.30	1.30	1.54	1.38	
24		2.18	1.54									
25				1.78	5.14	3.00	1.56	1.30	1.48	1.58	1.30	
26												
27	2.64			1.74	5.52	2.76	1.52	1.28	1.56	1.54	1.42	
28												
29				1.82	5.80	2.44	1.48	1.26	1.54	1.52	1.48	b 2.18
30												
31			1.52		5.62		1.44	1.24		1.48		

a Ice gorge below gage. b Solid ice.

CONEJOS RIVER NEAR LOS MOGOTES, COLORADO.

This river, the most important tributary of the Rio Grande in Colorado, rises on the eastern slope of the San Juan Range, which forms the western boundary of Conejos County. It first flows southeasterly, and then bends in a northeasterly direction at the town of Conejos, and enters the Rio Grande below the mouth of Trinchera Creek. The entire normal flow of the stream is used during the irrigation season; but during the flood stages and in the winter considerable water goes to waste.

The gaging station, which was established August 25, 1899, is about 10 miles west of Antonito, and is reached by driving from that town. It was first located at the wagon bridge crossing the river, but the rod at that point being maliciously destroyed, the station was moved about 500 yards downstream, where it was attached to a pier projecting into the river near a farmhouse. The channel is fairly good, being of gravel, and not particularly subject to change or overflow. Owing to the removal of the gage from its old station, no rating table was possible for 1899, and but few measurements were made in 1900. Records were kept for one month only, for the reason that the observer, Gustav Timm, moved away early in the season, and no one was found to make the observations.

San Antonio River, a branch of Conejos River, was measured twice during the season, about a half mile south of Antonito. The discharge on May 11 was 473 second-feet, and on June 22 it was 4 second-feet. After that the stream was practically dry.

A description of the Los Mogotes station was published in Water-Supply Paper No. 37, page 278. During 1900 the following measurements were made by A. L. Fellows:

March 28: Gage height, 1.68 feet; discharge, 144 second-feet.
May 11: Gage height, 3.10 feet; discharge, 1,087 second-feet.
August 17: Gage height, 1.15 feet; discharge, 33 second-feet.
June 23: Gage height, 2.30 feet; discharge, 467 second-feet.

Daily gage height, in feet, of Conejos River near Los Mogotes, Colorado, for 1900.

Day.	Mar.	Day.	Mar.	Day.	Mar.	Day.	Mar.
1	2.60	9	2.55	17	1.85	25	1.80
2	2.60	10	2.45	18	1.75	26	1.80
3	2.62	11	1.75	19	1.70	27	1.80
4	2.62	12	1.85	20	1.80	28	1.85
5	2.65	13	1.85	21	1.80	29	1.80
6	2.65	14	1.98	22	1.80	30	1.75
7	2.30	15	1.85	23	1.80	31	1.95
8	2.50	16	1.85	24	1.80		

RIO GRANDE AT CENICERO, COLORADO.

This station is a short distance above the Colorado State line, at a point where the river is crossed by a wagon bridge. Gagings were

begun July 28, 1899, since which time continuous records have been kept. There are two gage rods, one for high water and the other for low water. The high-water rod is a 2-inch by 6-inch timber attached to the west side of the central downstream cylinder of the bridge. The low-water rod is a scale, marked in feet and tenths, on the perpendicular face of a large bowlder about a hundred yards below the bridge. The channel is in most respects an excellent one. The bed consists of bowlders and rock, and is subject to little change; the banks are high and are not subject to overflow. Gagings can be made at the bridge, but during low water they are usually made by wading. On June 22, 1900, both gages were referred to a bench mark consisting of a chiseled point marked "B. M." on the face of the lava bluff under the west end of the bridge, 7.42 feet above gage datum. The station is an extremely important one, giving, as it does, the discharge of the river at the Colorado State line, including practically all of the Colorado drainage. Roman Mondragon, who keeps a store at the west end of the bridge, has kept the records during the last year.

A description of this station was published in Water-Supply Paper No. 37, page 279. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 257. During 1900 the following measurements were made by A. L. Fellows:

March 29: Gage height, 1.60 feet; discharge, 236 second-feet.
June 22: Gage height, 1.80 feet; discharge, 420 second-feet.
May 10: Gage height, 2 feet; discharge, 594 second-feet.
August 16: Gage height, 0.75 foot; discharge, 18 second-feet.

Daily gage height, in feet, of Rio Grande at Cenicero, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.0	2.5	1.6	1.8	5.0	1.1	0.8	0.7	0.9	1.1	1.8
2	2.0	2.0	2.6	1.6	1.9	4.8	1.0	.8	.7	.9	1.1	1.8
3	2.0	2.3	2.6	1.6	1.9	4.7	1.0	.8	.8	.9	1.1	1.8
4	2.0	2.0	2.4	1.7	1.9	4.6	.9	.8	.8	.9	1.1	1.9
5	2.0	2.0	2.1	1.7	1.9	4.5	.9	.8	.9	.9	1.1	1.9
6	2.0	2.0	2.1	1.8	1.9	4.2	.9	.8	.9	.9	1.1	2.0
7	2.0	2.0	2.1	1.8	1.9	4.0	.9	.8	.9	.9	1.1	2.0
8	2.0	2.6	2.2	1.8	2.0	3.9	.9	.8	.9	.9	1.1	2.0
9	2.0	2.6	2.0	1.8	2.0	3.8	.9	.8	.9	.9	1.1	2.0
10	2.0	2.0	2.0	1.8	2.1	3.8	.9	.8	1.0	.9	1.1	2.0
11	2.0	2.0	2.1	1.8	2.2	3.7	.9	.8	.9	.9	1.1	2.0
12	2.0	2.0	2.1	1.8	2.7	3.6	.9	.8	1.0	.9	1.1	2.0
13	2.0	2.0	2.1	1.8	2.8	3.2	.9	.8	1.0	.9	1.1	2.0
14	2.0	2.0	2.1	1.7	2.9	3.0	.9	.8	.9	.9	1.1	2.0
15	2.0	.9	2.1	1.7	2.9	2.9	.9	.8	.9	.9	1.1	2.0
16	2.0	.8	2.1	1.7	2.9	2.7	.9	.8	.9	.9	1.1	2.0
17	2.0	2.4	2.0	1.7	2.9	2.5	.9	.8	.9	.9	1.1	2.0
18	2.0	2.4	1.9	1.7	2.8	2.4	.9	.8	.9	.9	1.2	2.0
19	2.0	2.4	1.9	1.6	3.0	2.2	.9	.8	.9	1.0	1.3	2.0
20	2.0	2.4	1.9	1.6	3.1	2.0	.9	.8	.9	1.0	1.9	2.0
21	2.0	2.4	1.9	1.5	3.8	1.9	.8	.8	.9	1.0	1.8	2.0
22	2.0	2.4	1.8	1.6	3.5	1.8	.8	.8	.9	1.0	1.8	2.0
23	2.0	2.4	1.8	1.6	3.3	1.8	.8	.8	.9	1.0	1.7	2.0
24	2.0	2.4	1.7	1.8	3.1	1.6	.8	.8	.9	1.0	1.6	2.0
25	2.6	2.4	1.7	1.8	3.1	1.6	.8	.8	.9	1.0	1.6	2.0
26	2.3	2.4	1.7	1.8	3.4	1.5	.8	.8	.9	1.0	1.6	2.0
27	2.0	2.4	1.7	1.9	3.9	1.5	.8	.8	.9	1.0	1.7	2.0
28	2.0	2.5	1.6	1.9	4.4	1.4	.8	.8	.9	1.0	1.5	2.0
29	2.0	.....	1.6	1.8	4.8	1.3	.8	.8	.9	1.0	1.5	2.0
30	2.6	.....	1.6	1.8	5.0	1.2	.8	.8	.9	1.1	1.8	2.0
31	2.0	.....	1.6	.....	5.0	.....	.8	.7	.....	1.1	.....	2.0

RIO GRANDE AT EMBUDO, NEW MEXICO.

This station, established in 1889, is about 300 feet east of the railroad station at Embudo. It is described in Water-Supply Paper No. 37, page 280. The results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 251; for 1897, Nineteenth Annual Report, Part IV, page 385; for 1889 to 1898, Twentieth Annual Report, Part IV, page 366; for 1899, Twenty-first Annual Report, Part IV, page 258. During 1900 the following measurements of discharge were made by P. E. Harroun:

Discharge measurements of Rio Grande at Embudo, New Mexico.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 10	7.90	529	June 27	8.00	587
April 21	7.65	495	August 3	7.00	179
May 23	11.00	3,581	August 29	6.90	167
May 30	11.70	6,139	September 25	7.20	244
June 6	11.20	4,786	November 8	7.30	282
June 15	10.20	2,375	December 4	7.50	353
June 22	8.55	840			

Daily gage height, in feet, of Rio Grande at Embudo, New Mexico, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.70	7.80	7.90	7.80	7.80	11.90	7.75	7.10	6.90	7.20	7.30	7.60
2	7.70	7.80	8.05	7.80	7.90	11.75	7.70	7.10	6.90	7.20	7.20	7.55
3	7.70	7.80	8.40	7.80	8.10	11.65	7.70	7.00	7.60	7.20	7.20	7.45
4	7.70	7.80	8.35	7.80	8.15	11.45	7.75	7.00	7.45	7.20	7.20	7.40
5	7.70	7.80	8.30	7.80	8.20	11.40	7.75	7.00	7.40	7.20	7.20	7.40
6	7.70	7.80	8.30	7.90	8.25	11.35	7.70	7.00	7.20	7.20	7.20	7.40
7	7.70	7.85	8.30	7.90	8.25	11.30	7.70	7.00	7.15	7.20	7.20	7.40
8	7.70	7.90	8.30	7.90	8.20	11.30	7.60	7.00	7.10	7.20	7.30	7.40
9	7.65	7.80	8.30	7.90	8.45	11.20	7.55	7.00	7.10	7.20	7.30	7.30
10	7.60	7.80	8.30	7.90	8.90	11.20	7.45	7.00	7.10	7.20	7.30	7.30
11	7.50	7.80	8.30	7.90	9.35	11.00	7.30	7.00	7.10	7.20	7.30	7.30
12	7.50	7.80	8.30	7.80	9.60	10.85	7.20	7.00	7.30	7.20	7.30	7.35
13	7.60	7.80	8.30	7.80	9.95	10.60	7.20	7.00	7.40	7.20	7.30	7.45
14	7.65	7.80	8.30	7.80	10.10	10.35	7.20	7.00	7.35	7.20	7.30	7.55
15	7.70	7.80	8.30	7.80	10.10	10.20	7.15	7.00	7.25	7.20	7.30	7.60
16	7.80	7.80	8.30	7.80	10.10	10.05	7.10	7.00	7.20	7.20	7.30	7.60
17	7.80	7.80	8.30	7.80	10.00	9.60	7.10	7.00	7.20	7.20	7.30	7.60
18	7.80	7.80	8.30	7.75	9.90	9.20	7.10	7.00	7.20	7.20	7.35	7.60
19	7.85	7.80	8.30	7.70	10.30	9.05	7.10	7.00	7.20	7.20	7.40	7.60
20	7.90	7.80	8.30	7.60	11.30	8.85	7.00	7.00	7.20	7.20	7.50	7.55
21	7.90	7.80	8.05	7.60	10.45	8.65	7.00	7.00	7.20	7.20	7.55	7.50
22	7.90	7.80	8.00	7.60	11.15	8.50	7.00	6.95	7.20	7.20	7.60	7.50
23	7.85	7.80	7.90	7.60	11.00	8.50	7.05	6.90	7.20	7.20	7.60	7.50
24	7.80	7.80	7.85	7.60	10.80	8.40	7.10	6.90	7.10	7.20	7.60	7.50
25	7.80	7.80	7.80	7.70	10.80	8.25	7.10	6.90	7.15	7.20	7.60	7.50
26	7.80	7.80	7.80	7.75	10.90	8.10	7.10	6.90	7.20	7.30	7.65	7.50
27	7.80	7.80	7.80	7.80	11.35	8.00	7.10	6.90	7.20	7.30	7.75	7.55
28	7.80	7.80	7.80	7.80	11.65	7.90	7.10	6.90	7.20	7.30	7.90	7.60
29	7.80	.....	7.80	7.80	11.75	7.80	7.10	6.90	7.20	7.30	7.75	7.60
30	7.80	.....	7.80	7.80	12.00	7.80	7.10	6.90	7.20	7.30	7.70	7.60
31	7.85	.....	7.80	.....	11.95	.....	7.10	6.90	.....	7.30	.....	7.60

RIO GRANDE AT RIO GRANDE, NEW MEXICO.

This station, established February 3, 1895, is about one-fourth of a mile above the railroad station at Rio Grande, and at the head of White Rock Canyon. It is described in Water-Supply Paper No. 37,

page 281. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 254; for 1897, Nineteenth Annual Report, Part IV, page 386; for 1898, Twentieth Annual Report, Part IV, page 370; for 1899, Twenty-first Annual Report, Part IV, page 259. During 1900 the following measurements were made by P. E. Harroun:

Discharge measurements of Rio Grande at Rio Grande, New Mexico.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 9	6.00	830	June 21	6.85	1,095
April 29	5.70	666	June 26	5.50	663
May 22	9.80	4,729	August 2	4.10	158
May 29	10.20	6,184	November 10	5.00	356
June 5	10.00	6,084	December 6	5.10	464
June 13	8.40	3,260			

Daily gage height, in feet, of Rio Grande at Rio Grande, New Mexico, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.55	5.50	5.70	5.75	6.35	10.45	5.05	4.15	4.00	4.80	5.00	5.20
2	5.40	5.50	5.65	5.90	6.60	10.40	4.95	4.10	4.00	4.80	4.90	5.20
3	5.40	5.50	5.90	6.25	6.75	10.30	4.80	4.10	4.15	4.90	4.90	5.20
4	5.70	5.50	5.90	6.00	6.60	10.20	5.45	4.10	4.70	4.90	4.90	5.25
5	5.65	5.50	6.15	6.00	6.80	10.00	5.50	4.10	6.20	4.80	4.95	5.15
6	5.45	5.50	6.25	6.10	7.45	9.55	5.35	4.20	5.55	4.80	4.95	5.15
7	5.60	5.60	6.15	5.95	7.40	9.30	5.10	4.20	10.00	4.75	4.90	5.25
8	5.50	5.60	6.00	6.00	7.25	9.15	5.00	4.20	7.30	4.75	4.95	5.30
9	5.65	5.35	6.00	6.10	7.65	8.90	5.05	4.30	6.25	4.75	4.90	5.25
10	5.60	4.95	6.00	6.05	8.00	8.85	4.85	4.45	5.80	4.70	4.90	5.35
11	5.55	5.25	6.00	5.85	8.35	8.80	4.70	4.80	5.20	4.70	4.95	5.35
12	5.30	5.55	6.25	5.80	8.80	8.60	4.65	4.25	5.40	4.75	4.90	5.30
13	5.60	5.50	6.35	5.75	8.95	8.35	4.60	4.20	5.60	4.75	4.90	5.30
14	5.55	5.55	6.60	5.80	8.95	8.05	4.45	4.15	5.40	4.80	4.90	5.25
15	5.65	5.55	6.85	5.95	8.85	7.55	4.35	4.20	5.05	4.95	4.85	5.20
16	5.65	5.55	6.55	5.95	8.70	7.45	4.25	4.15	4.90	4.95	4.90	5.20
17	5.65	5.35	6.45	5.85	8.50	7.15	4.25	4.10	4.80	5.00	4.85	5.05
18	5.55	5.35	6.40	5.85	8.40	6.95	4.20	4.10	4.85	4.95	4.85	4.90
19	5.45	5.45	6.20	5.75	9.15	6.65	4.20	4.10	4.95	4.95	4.90	5.10
20	5.40	5.55	5.95	5.75	9.55	6.35	4.10	4.10	4.95	4.95	5.05	5.05
21	5.50	5.55	5.95	5.90	9.60	6.25	4.15	4.10	4.85	4.90	5.15	5.15
22	5.60	5.50	5.95	6.75	9.75	6.15	4.10	4.10	4.75	5.00	5.20	5.15
23	5.60	5.45	5.85	6.60	9.75	6.40	4.15	4.00	4.75	4.95	5.15	5.05
24	5.55	5.60	5.85	6.35	9.35	5.85	4.25	4.00	4.70	5.00	5.15	4.90
25	5.60	5.55	5.80	6.25	9.25	5.90	4.20	4.00	4.70	4.95	5.20	4.85
26	5.55	5.55	5.75	6.15	9.40	5.70	4.25	3.90	4.70	5.00	5.15	4.90
27	5.55	5.70	5.65	6.00	9.90	5.45	4.20	3.90	4.70	5.10	5.20	5.05
28	5.50	5.65	5.75	6.20	9.95	5.35	4.20	3.90	4.80	5.05	5.35	5.00
29	5.40	.....	5.65	6.50	10.20	5.15	4.15	3.90	4.80	5.00	5.25	5.00
30	5.35	.....	5.55	6.25	10.40	5.80	4.20	3.90	4.80	5.00	5.25	5.00
31	5.50	.....	5.55	.....	10.45	.....	4.20	3.90	.....	5.00	.....	4.95

RIO GRANDE NEAR SAN MARCIAL, NEW MEXICO.

This station, established January 29, 1895, is at the railroad bridge a half mile south of the town. It is described in Water-Supply Paper No. 37, page 282. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 257; for 1897, Nineteenth Annual Report, Part IV, page 387; for 1898, Twentieth Annual Report, Part IV, page 371; for 1899, Twenty-first Annual

Report, Part IV, page 261. During 1900 the following discharge measurements were made by P. E. Harroun:

Discharge measurements of Rio Grande near San Marcial, New Mexico.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 6	5.88	20	June 18	7.70	1,410
April 18	6.70	170	June 24	7.30	605
April 27	5.85	6	June 30	6.40	59
May 19	8.00	2,074	September 11	8.05	3,474
May 27	7.90	2,979	November 13	5.60	43
June 3	9.40	6,855	December 20	6.80	198
June 10	8.50	3,166			

Daily gage height, in feet, of Rio Grande near San Marcial, New Mexico, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.75	6.80	6.70	6.40	6.50	9.05	6.10	4.30	3.30	5.30	5.20	6.45
2	6.90	6.80	6.80	6.25	6.60	9.40	5.90	4.30	3.30	5.20	5.30	6.45
3	6.90	6.75	6.80	6.20	6.60	9.50	5.80	4.20	3.30	5.10	5.35	6.40
4	6.80	6.70	6.80	6.10	6.70	9.35	5.70	4.20	3.30	5.00	5.50	6.50
5	6.80	6.85	6.80	6.00	6.70	9.40	5.70	4.10	3.30	5.00	5.50	6.50
6	6.60	7.00	6.80	5.90	6.70	9.25	5.60	4.10	3.30	4.90	5.50	6.60
7	6.50	6.90	6.80	5.80	6.70	9.00	5.70	4.10	3.30	4.90	5.60	6.60
8	6.60	6.90	6.80	5.80	6.80	8.90	5.65	4.10	7.15	4.90	5.60	6.60
9	6.65	6.90	6.80	6.35	7.25	8.75	5.40	4.10	9.20	4.80	5.60	6.70
10	6.95	6.75	6.80	6.50	7.40	8.50	5.40	4.10	9.10	4.80	5.70	6.70
11	6.90	6.70	6.95	6.60	7.40	8.45	5.30	3.90	8.00	4.70	5.70	6.70
12	6.80	6.85	6.90	6.50	7.40	8.55	5.25	3.90	7.35	4.70	5.70	6.70
13	6.70	6.80	6.90	6.50	7.85	8.75	5.20	3.90	6.65	4.60	5.70	6.70
14	6.70	6.60	6.90	6.50	8.25	8.45	5.10	3.90	8.25	4.60	5.70	6.70
15	6.80	6.60	6.70	6.70	8.25	8.00	5.10	3.90	7.20	4.50	5.70	6.70
16	6.90	6.70	6.80	6.70	8.00	7.95	5.10	3.90	6.70	4.50	5.80	6.70
17	6.80	6.85	6.90	6.70	7.90	7.70	5.00	3.90	6.35	4.40	5.80	6.70
18	6.85	6.80	7.00	6.70	7.75	7.70	5.00	3.80	6.20	4.60	5.80	6.70
19	6.80	6.70	7.55	6.65	7.90	7.60	5.00	3.80	6.10	4.60	5.80	6.70
20	6.95	6.90	7.15	6.60	7.85	7.50	4.90	3.80	6.00	4.70	5.90	6.70
21	7.00	6.95	7.10	6.55	9.03	7.40	4.90	3.80	5.90	4.70	5.90	6.70
22	6.95	6.90	7.10	6.55	9.30	7.30	4.90	3.80	5.90	4.70	5.90	6.70
23	6.90	6.85	7.00	6.50	8.85	7.30	4.80	3.80	5.80	4.80	6.00	6.70
24	6.80	6.80	7.00	6.00	8.75	7.25	4.80	3.80	5.70	4.80	6.00	6.85
25	6.85	6.85	6.90	5.60	8.65	7.25	4.70	3.60	5.60	4.90	6.10	6.85
26	6.95	6.80	6.90	5.60	8.55	7.10	4.70	3.60	5.50	4.90	6.10	6.85
27	6.75	6.75	6.90	5.60	8.40	6.85	4.60	3.60	5.70	5.00	6.20	6.95
28	6.90	6.70	6.85	5.75	8.30	6.60	4.50	3.60	5.65	5.00	6.20	6.90
29	6.80	.....	6.70	6.50	8.55	6.50	4.50	3.60	5.40	5.10	6.30	6.50
30	6.90	.....	6.60	6.60	8.75	6.35	4.40	3.60	5.30	5.10	6.30	5.90
31	6.90	.....	6.50	.....	8.95	.....	4.40	3.60	.....	5.20	.....	5.65

RIO GRANDE NEAR EL PASO, TEXAS.

Measurements of the Rio Grande have been made at this place for a long time, during the last three years under the direction of W. W. Follett, consulting engineer of the International (Water) Boundary Commission, and by his successor, P. D. Cunningham. The present station is at Courchesne's limekiln, 4 miles north of El Paso. It is described in Water-Supply Paper No. 37, page 283. Results of measurements for 1899 will be found in the Twenty-first Annual Report,

Part IV, page 262. During 1900 the following discharge measurements were made by T. N. Courchesne:

Discharge measurements of Rio Grande near El Paso, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 3	5.40	90	February 27	5.40	89
January 6	5.40	93	March 3	4.50	13
January 9	5.40	89	May 17	6.50	518
January 11	5.80	151	May 18	7.50	908
January 13	6.50	341	May 22	7.50	769
January 16	6.20	246	May 26	9.30	2,120
January 18	5.90	143	May 28	9.20	2,146
January 22	5.50	102	June 1	9.60	2,369
January 24	5.60	111	June 6	10.40	3,500
January 27	5.60	113	June 9	10.40	3,319
January 30	5.50	94	June 10	10.30	2,686
February 1	5.50	100	June 13	9.50	1,680
February 3	5.40	90	June 18	8.30	957
February 6	5.40	88	June 22	7.10	358
February 8	5.50	105	June 25	6.20	131
February 10	5.60	108	June 27	5.90	95
February 13	5.60	117	June 30	5.40	17
February 15	5.50	101	September 9	8.40	1,164
February 19	5.80	134	September 13	9.40	2,005
February 22	5.40	94	September 17	8.70	1,278
February 24	5.30	77	September 22	6.20	126

Daily gage height, in feet, of Rio Grande near El Paso, Texas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Sept.	Dec.
1	5.40	5.50	5.15	4.30	4.30	9.65	5.10	(a)	(b)
2	5.40	5.40	4.90	4.30	4.30	9.65	5.00	.....	.....
3	5.40	5.40	4.65	4.30	4.30	10.05	5.00	.....	.....
4	5.40	5.40	4.35	4.30	4.30	10.30	5.00	.....	.....
5	5.45	5.40	(c)	4.30	4.30	10.40	5.00	.....	.....
6	5.45	5.40	(c)	4.30	(c)	10.45	5.00	.....	.....
7	5.40	5.50	(c)	4.30	(c)	10.45	5.00	.....	.....
8	5.40	5.50	(c)	4.30	(c)	10.40	(a)	.....	.....
9	5.45	5.50	(c)	4.30	(c)	10.40	.....	8.00	.....
10	5.65	5.55	(c)	4.30	(c)	10.35	.....	5.90	.....
11	5.80	5.60	(c)	4.30	(c)	10.10	.....	5.10	.....
12	5.75	5.60	(c)	4.30	(c)	9.75	.....	6.15	.....
13	6.45	5.60	(c)	4.30	(c)	9.40	.....	9.10	.....
14	6.35	5.60	(c)	4.30	(c)	9.30	.....	8.35	.....
15	6.30	5.50	(c)	4.30	(c)	9.25	.....	7.85	.....
16	6.15	5.50	(c)	4.30	(c)	9.15	.....	7.75	.....
17	5.95	5.50	(c)	4.30	6.80	8.45	.....	8.50	.....
18	5.85	5.90	(c)	4.30	7.55	8.30	.....	7.75	.....
19	5.70	5.80	(c)	4.30	7.65	7.90	.....	7.05	.....
20	5.60	5.70	(c)	4.30	7.65	7.60	.....	6.35	.....
21	5.60	5.55	(c)	4.30	7.65	7.35	.....	6.30	.....
22	5.50	5.40	(c)	4.30	7.55	7.00	.....	6.15	5.05
23	5.50	5.40	(c)	4.30	7.40	6.75	.....	6.20	5.40
24	5.60	5.35	4.65	4.30	8.25	6.45	.....	5.60	5.40
25	5.60	5.30	4.55	4.30	9.80	6.25	.....	5.50	5.40
26	5.60	5.40	4.40	4.30	9.30	6.05	.....	5.40	5.40
27	5.60	5.40	4.30	4.30	9.25	5.90	.....	5.40	5.40
28	5.60	5.40	4.30	4.30	9.20	5.75	.....	5.25	5.35
29	5.55	.....	4.30	4.30	9.10	5.55	.....	5.10	5.15
30	5.50	.....	4.30	4.30	9.30	5.30	.....	5.00	5.10
31	5.50	.....	4.30	.....	9.40	.....	.....	.....	5.10

a River dry from July 8 to September 9.
b River dry from October 1 to December 23.
c River dry.

LOWER RIO GRANDE.

During 1900 the International (Water) Boundary Commission established a number of gaging stations on the Rio Grande below El Paso, Texas, and on some of its tributary streams, as noted below. This commission has had charge of the investigation looking toward the building of an international dam at El Paso, and the stations were established in order to obtain data regarding the fluctuations of the lower river to determine questions which had arisen in connection with hydrographic problems. Information regarding the river at the several localities where stations have been established has been furnished through the courtesy of Gen. Anson Mills, chairman of the International (Water) Boundary Commission. The stations are as follows, in order downstream: Rio Grande near Fort Hancock, Texas; Rio Grande 7 miles above Presidio, Texas; Rio Grande 6 miles below Presidio, Texas; Rio Grande near Langtry, Texas; Pecos River near Moorhead, Texas; Devils River near Devilsriver, Texas; Rio Grande near Devilsriver, Texas; and Rio Grande near Eagle Pass, Texas.

RIO GRANDE NEAR FORT HANCOCK, TEXAS.

This station was established March 27, 1900, by the International (Water) Boundary Commission. It is one and one-half miles southeast of Fort Hancock, on the Southern Pacific Railway, in the El Paso Valley, and is about 55 miles below El Paso. During 1900 the following measurements of discharge were made:

Discharge measurements of Rio Grande near Fort Hancock, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 24	4.00	217	June 16	6.30	971
May 27	7.60	1,627	June 19	5.60	527
May 30	6.80	1,082	June 23	3.80	186
June 4	7.30	1,399	June 28	2.60	14
June 8	8.00	2,368	September 25	−.10	13

Daily gage height, in feet, of Rio Grande near Fort Hancock, Texas, for 1900.

Day.	May.	June.	Sept.[b]	Oct.	Day.	May.	June.	Sept.[b]	Oct.	Day.	May.	June.	Sept.[b]	Oct.
1	(a)	6.70	.60	−.50	12	.....	7.15	−.10	−.30	23	4.00	3.60	.10	−.10
2	.....	7.15	.60	−.50	13	.....	6.75	−.10	−.30	24	4.00	3.30	.10	−.10
3	.....	7.10	.60	−.50	14	.....	6.55	−.10	−.30	25	4.30	3.10	−.10	−.10
4	.....	7.25	60	−.50	15	.....	6.45	1.50	−.30	26	7.80	2.90	−.10	−.10
5	.....	7.25	1.30	−.30	16	.....	6.35	1.10	−.30	27	7.50	2.90	−.10	−.10
6	.....	7.85	.90	−.30	17	.....	6.55	.90	5.00	28	7.00	2.60	−.50	−.10
7	.....	7.90	.40	−.30	18	.....	5.70	1.35	4.00	29	6.90	1.80	−.50	−.10
8	.....	7.95	−.10	−.30	19	.....	5.50	1.20	1.10	30	6.80	.80	−.50	−.10
9	.....	8.00	−.10	−.30	20	.....	4.90	.90	−.10	31	6.65	(b)	.....	−.10
10	.....	7.75	−.10	−.30	21	3.80	4.50	.80	−.10					
11	.....	7.50	−.10	−.30	22	3.90	4.00	.30	−.10					

a River dry from March 27 to May 21.
b River dry from July 1 to September 1; also throughout November and December.

RIO GRANDE ABOVE PRESIDIO, TEXAS.

This station was established April 4, 1900, by the International (Water) Boundary Commission. It is 7 miles above Presidio and above the mouth of Concho River, one of the principal tributaries of the Rio Grande, and is about 200 miles below El Paso. Its location is far enough above the mouth of Concho River to be free from the effects of backwater from that stream. During 1900 the following measurements of discharge were made:

Discharge measurements of Rio Grande above Presidio, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 23	2.00	101	July 2	1.80	116
May 26	0.00	000	July 5	1.70	59
May 28	2.00	96	July 7	2.30	218
June 1	4.20	907	July 28	2.20	198
June 6	4.20	901	August 4	1.50	54
June 8	4.40	1,157	September 24	2.70	305
June 11	5.35	1,589	September 27	1.70	46
June 13	6.50	2,376	October 3	2.10	80
June 15	4.60	1,170	October 18	4.75	970
June 18	3.60	692	October 20	5.10	1,435
June 22	3.00	400	October 23	2.10	125
June 25	2.30	192	October 25	1.60	45
June 27	1.50	110			

Daily gage height, in feet, of Rio Grande above Presidio, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	(a)	4.10	(b)	(b)	(b)	3.75	17	(a)	3.60	(b)	(b)	(b)	3.50
2	.....	3.50	3.00	2.50	(b)	2.60	18	.....	3.60	(b)	(b)	(b)	5.25
3	.....	3.00	5.50	1.20	3.10	2.40	19	.....	3.40	2.60	(b)	(b)	2.30
4	.....	4.00	3.00	1.05	(b)	1.10	20	.....	4.10	3.40	(b)	(b)	3.40
5	.....	4.00	1.75	.....	(b)	(b)	21	.....	3.35	2.35	2.00	3.20	3.20
6	.....	4.20	2.90	2.05	.70	(b)	22	2.50	3.00	1.75	1.95	2.75	2.40
7	.....	4.20	2.50	.30	2.85	(b)	23	2.00	2.70	1.80	.60	4.10	2.15
8	.....	4.40	2.50	1.15	1.65	(b)	24	(b)	2.45	(b)	(b)	2.55	1.75
9	.....	5.00	1.50	2.75	(b)	(b)	25	(b)	2.15	1.05	(b)	1.25	1.55
10	.....	5.15	1.00	2.05	(b)	(b)	26	(b)	1.70	.55	(b)	1.15	1.35
11	.....	5.30	2.50	1.50	(b)	(b)	27	1.90	1.55	2.00	(b)	1.65	.95
12	.....	6.15	1.50	(b)	(b)	(b)	28	3.55	1.75	(b)	(b)	2.45	1.00
13	.....	5.90	(b)	.25	(b)	(b)	29	(b)	1.45	(b)	(b)	5.70	.85
14	.....	5.00	(b)	(b)	(b)	(b)	30	2.45	1.45	(b)	(b)	7.00	.60
15	.....	4.45	(b)	.95	(b)	(o)	31	3.50	.....	(b)	(b)	.....	(c)
16	.....	4.15	(b)	(b)	(b)	(b)							

a River dry from April 4 to May 21.
b River dry.
c River dry throughout November and December.

RIO GRANDE BELOW PRESIDIO, TEXAS.

This station was established April 8, 1900, by the International (Water) Boundary Commission. It is 6 miles below Presidio, also below the mouth of Concho River, and about 215 miles below El Paso. It is at the western end of the canyon section of the Rio Grande.

During 1900 the following measurements of discharge were made:

Discharge measurements of Rio Grande below Presidio, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 20	3.40	14	September 10	8.90	5,061
May 22	8.30	1,762	September 12	8.95	4,082
May 25	4.90	66	September 14	8.35	2,797
May 29	4.85	98	September 17	7.45	1,725
June 7	7.10	1,030	September 19	7.20	1,262
June 9	7.45	1,318	September 25	6.85	1,249
June 12	8.70	2,213	September 28	7.90	2,169
June 14	7.50	1,668	October 4	7.75	2,573
June 16	6.50	1,021	October 6	7.60	2,112
June 19	6.00	735	October 9	7.80	2,265
June 21	5.85	710	October 11	7.25	1,602
June 23	5.10	355	October 13	7.45	1,685
June 26	4.40	167	October 15	6.70	1,127
June 28	4.40	107	October 17	9.50	4,702
July 3	6.40	729	October 19	7.20	1,497
July 6	5.10	275	October 22	6.70	1,158
July 9	8.40	1,425	October 24	6.20	893
July 12	11.30	8,834	October 27	6.05	731
July 14	10.50	6,890	October 29	5.90	601
July 17	8.45	2,655	November 5	5.60	492
July 19	8.25	2,477	November 7	5.60	476
July 22	9.40	4,068	November 10	5.50	459
July 24	10.80	7,893	November 12	5.50	431
July 26	9.85	5,608	November 14	5.40	403
July 28	10.60	7,491	November 16	5.40	399
August 1	11.75	11,586	November 19	5.30	370
August 3	11.75	12,784	November 22	5.20	333
August 6	12.95	16,049	November 26	5.20	311
August 9	11.35	10,357	November 28	5.10	288
August 11	10.40	7,032	December 3	5.00	256
August 13	9.35	5,001	December 8	5.00	255
August 15	9.00	4,129	December 10	5.00	248
August 21	7.60	2,053	December 13	5.00	248
August 23	8.90	4,035	December 20	5.00	220
August 25	9.20	4,823	December 22	5.00	225
August 28	8.05	2,643	December 24	4.90	214
August 30	7.50	2,039	December 27	4.90	211
September 5	7.00	1,437	December 29	4.90	213
September 7	7.80	2,367			

Daily gage height, in feet, of Rio Grande below Presidio, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	8.40	6.75	11.70	7.10	8.30	5.80	5.20
2	3.70	8.20	6.20	10.60	7.20	7.90	5.70	5.20
3	3.65	7.40	7.07	12.05	11.85	8.35	5.70	5.00
4	3.60	7.00	8.75	10.65	7.30	7.75	5.70	5.00
5	3.60	7.05	5.80	11.20	7.05	7.75	5.60	5.00
6	3.60	7.05	5.15	12.60	6.85	7.60	5.60	5.00
7	3.60	7.00	6.40	11.75	7.85	7.65	5.60	5.00
8	3.50	7.15	8.75	12.20	8.15	7.60	5.60	5.00
9	3.50	7.50	8.25	11.40	8.60	7.70	5.60	5.00
10	3.50	7.60	11.50	10.95	8.80	7.40	5.50	5.00
11	4.50	7.85	12.90	10.80	9.40	7.25	5.50	5.00
12	3.50	8.80	11.60	10.05	8.65	7.20	5.50	5.00
13	3.50	9.85	11.45	9.55	8.65	7.45	5.50	5.00
14	3.50	7.55	10.35	9.50	8.30	6.95	5.40	5.00
15	3.50	6.85	8.90	8.90	7.95	6.75	5.40	5.00
16	3.50	6.60	7.90	8.85	7.75	7.15	5.40	5.00
17	3.50	6.35	8.55	8.70	7.45	9.50	5.40	5.00
18	3.45	6.05	7.95	8.30	7.10	7.80	5.30	5.00
19	3.40	5.95	8.15	8.35	7.10	7.15	5.30	5.00
20	3.40	6.40	8.55	7.90	6.90	7.60	5.30	5.00
21	10.25	5.95	8.75	7.90	7.00	7.10	5.30	5.00
22	7.77	5.45	8.55	8.20	8.15	6.75	5.30	5.00
23	6.15	5.05	9.65	9.05	7.90	6.55	5.20	4.90
24	5.35	4.95	10.80	9.40	7.35	6.35	5.20	4.90
25	4.90	4.45	10.55	9.30	6.85	6.30	5.20	4.90
26	4.70	4.45	9.85	8.75	7.30	6.15	5.20	4.90
27	6.15	4.25	10.90	8.35	8.55	6.15	5.20	4.90
28	5.60	4.40	10.70	7.95	9.00	6.05	5.20	4.90
29	4.80	4.55	10.65	7.75	9.10	6.00	5.20	4.90
30	4.40	7.60	10.55	7.55	9.30	6.00	5.20	4.90
31	7.15	.....	10.85	7.35	.....	5.80	.....	4.90

RIO GRANDE NEAR LANGTRY, TEXAS.

This station was established in April, 1900, by the International (Water) Boundary Commission. It is located one-half mile south of Langtry station on the Southern Pacific Railway, and is about 440 miles below El Paso, Texas, at the eastern end of the canyon section of the Rio Grande, and a short distance to the west of the mouth of Pecos River, one of the principal tributaries of the Rio Grande. The following measurements of discharge were made in 1900:

Discharge measurements of Rio Grande near Langtry, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 11	1.60	513	August 21	5.80	9,394
Do	1.60	406	August 25	3.40	3,693
May 12	1.50	351	August 29	3.70	4,153
May 15	1.60	371	September 2	2.90	2,515
May 16	1.60	478	September 7	3.30	3,427
May 23	3.90	3,826	September 12	3.40	3,313
May 29	1.80	859	September 16	3.40	3,712
June 2	2.85	2,273	September 22	2.40	1,920
June 5	2.80	1,991	September 26	3.25	3,441
June 10	2.10	1,339	October 2	3.90	4,688
June 13	3.30	2,958	October 8	2.90	2,674
June 17	3.25	2,893	October 12	2.60	2,325
June 24	2.60	1,701	October 15	2.40	2,020
June 28	1.70	811	October 23	2.50	2,285
July 2	2.20	1,348	October 26	2.00	1,630
July 5	5.45	8,287	October 31	1.70	1,124
July 9	2.35	1,428	November 4	1.65	1,070
July 12	3.65	3,499	November 8	1.55	992
July 15	6.90	11,836	November 12	1.45	888
July 18	4.70	5,617	November 16	1.40	858
July 22	3.20	2,751	November 21	1.40	836
July 26	5.20	7,671	November 26	1.30	772
July 30	5.45	8,390	November 30	1.30	761
August 2	5.70	8,236	December 5	1.25	726
August 6	6.30	10,100	December 10	1.20	685
August 8	11.25	24,401	December 14	1.15	667
August 13	5.90	8,561	December 20	1.20	680
August 16	4.35	5,258	December 24	1.15	644

Daily gage height, in feet, of Rio Grande near Langtry, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.75	2.70	5.55	2.85	3.40	1.65	1.30
2	2.30	3.95	2.80	5.60	2.90	3.90	1.60	1.30
3	1.80	2.75	3.05	6.25	2.90	4.00	1.60	1.30
4	1.70	2.10	3.05	6.25	4.70	3.55	1.60	1.30
5	1.85	2.85	4.65	8.30	7.35	2.85	1.55	1.20
6	1.75	3.05	3.45	6.00	4.75	3.35	1.50	1.20
7	1.75	2.60	3.10	6.30	3.15	2.95	1.50	1.20
8	1.95	2.45	2.75	10.30	2.80	2.85	1.55	1.20
9	1.90	2.25	2.25	9.25	2.70	2.80	1.80	1.20
10	1.75	2.30	2.10	7.50	2.95	2.80	1.70	1.20
11	1.60	2.30	3.35	6.90	3.20	2.85	1.50	1.20
12	1.50	2.30	3.40	6.30	3.55	2.60	1.45	1.20
13	1.55	3.25	7.50	5.80	4.25	2.55	1.40	1.20
14	1.55	3.45	6.80	5.20	4.00	2.50	1.40	1.20
15	1.55	3.40	6.70	4.80	3.65	2.30	1.40	1.20
16	1.70	4.15	4.40	4.40	3.35	2.25	1.40	1.20
17	1.50	3.15	4.05	4.25	3.10	2.40	1.40	1.20
18	1.50	2.85	4.60	3.80	2.75	5.15	1.40	1.20
19	1.45	2.55	3.95	3.80	2.70	4.50	1.40	1.20
20	1.65	2.40	3.70	5.75	2.60	4.30	1.40	1.20
21	1.95	2.65	3.40	5.80	2.50	3.75	1.40	1.20
22	4.10	2.90	3.20	5.10	2.45	2.80	1.40	1.20
23	3.65	2.95	4.90	4.30	3.45	2.40	1.40	1.20
24	3.75	2.55	3.50	3.45	2.85	2.50	1.40	1.15
25	2.90	2.20	3.25	3.30	3.35	2.25	1.30	1.15
26	2.35	1.95	5.40	3.35	3.15	2.10	1.30	1.10
27	2.25	1.80	5.30	3.40	2.90	2.00	1.30	1.10
28	1.95	1.70	4.95	3.40	3.85	2.00	1.30	1.10
29	1.85	3.05	5.50	3.55	4.80	1.90	1.30	1.10
30	1.60	2.55	5.35	3.50	3.20	1.90	1.30	1.10
31	1.50	.....	5.60	3.00	.....	1.75	.....	1.10

PECOS RIVER NEAR PECOS, TEXAS.

The gaging station is at the Margueretta flume, about 6 miles above the city of Pecos. The gage is vertical, and is nailed to one of the bents of the flume. The measurements are made above the flume, by wading, a wire being stretched across the river and tagged every 4 feet. The bottom is sand, and slight changes occur at every rise; but considering the character of the bottom it is remarkable that the changes of configuration of the cross section are so inconsiderable. The observer is Willard H. Dennis, and during the year 1900, in addition to his services as observer of daily gage heights, he obtained measurements of the velocity, a Price acoustic meter being used, from which the flow was calculated by Thomas U. Taylor. Discharge measurements and daily gage heights were also observed in the canal flume. This station is described in Water-Supply Paper No. 37, page 285.

During the year 1900 West Valley ditch, one of the diversions of Pecos River, was measured thirty-two times, as follows:

Discharge measurements of West Valley ditch.

Date.	Discharge.	Date.	Discharge.
1900.	*Sec.-ft.*	1900.	*Sec.-ft.*
April 22	12.0	July 15	10.6
April 26	10.0	July 18	14.0
April 30	18.0	July 21	17.4
May 9	12.0	July 23	10.8
May 11	12.0	July 25	11.0
May 14	12.8	August 1	14.0
May 16	12.5	August 4	11.8
May 18	10.4	August 6	18.3
May 20	13.6	August 10	8.0
May 22	15.0	August 20	11.8
June 4	16.0	August 24	16.6
June 6	17.0	September 3	12.0
July 1	11.4	September 5	13.5
July 5	11.4	November 20	12.0
July 7	13.7	December 1	20.3
July 13	13.6	December 4	14.3

The average flow of West Valley ditch through the season is 12 second-feet.

During 1900 the following measurements of discharge of the river were made:

Discharge measurements of Pecos River near Pecos, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
February 25	2.60	273	July 7	3.15	276
March 3	1.90	144	July 13	1.90	92
March 6	1.70	140	July 15	1.60	59
March 9	1.60	125	July 18	1.52	47
March 11	1.50	110	July 21	3.30	353
March 13	1.20	69	July 23	3.50	398
March 17	1.75	143	July 25	2.60	193
March 20	1.00	50	August 1	3.15	311
March 28	.90	43	August 4	2.20	125
April 1	.80	39	August 6	1.75	70
April 8	.70	25	August 10	3.55	335
April 16	.60	23	August 13	2.55	135
April 22	.60	21	August 20	3.30	333
April 26	.50	20	August 24	3.40	273
April 30	.50	21	September 3	1.90	58
May 9	3.10	277	September 5	1.90	62
May 11	2.50	126	November 20	2.62	214
May 14	2.00	69	December 1	2.40	168
May 16	.....	330	December 4	2.28	148
May 18	2.80	221	December 8	2.20	132
May 20	2.40	153	December 11	2.10	127
May 22	2.90	260	December 15	2.17	135
June 6	3.30	258	Do	2.10	127
June 4	2.90	216	December 17	2.12	136
July 1	2.00	89	December 19	2.00	135
July 5	1.80	70			

Discharge measurements of Margueretta flume near Pecos, Texas.

Date.	Discharge.	Date.	Discharge.
1900.	*Sec.-ft.*	1900.	*Sec.-ft.*
February 25	29	May 22	155
March 3	81	June 4	127
March 6	84	June 6	140
March 9	79	July 1	127
March 11	75	July 5	148
March 13	104	July 7	146
March 17	44	July 13	140
March 20	115	July 15	129
March 28	115	July 18	135
April 1	117	July 21	210
April 8	108	July 23	209
April 16	115	July 25	185
April 22	115	August 1	131
April 26	118	August 4	151
April 30	106	August 6	137
May 9	138	August 10	124
May 11	127	August 13	147
May 14	125	August 20	165
May 16	162	August 24	156
May 18	94	September 3	160
May 20	137		

Daily gage height, in feet, of Pecos River near Pecos, Texas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	3.35	2.50	0.80	6.05	4.75	2.00	3.20	1.90	6.30	4.15	2.40
2	2.90	3.35	2.35	.80	4.70	3.80	1.90	3.00	1.80	6.10	4.00	2.40
3	2.90	3.30	1.95	.85	7.15	3.25	2.05	2.60	1.85	7.05	4.00	2.40
4	2.90	3.35	1.90	.70	6.60	3.05	2.05	2.25	1.94	7.65	4.00	2.30
5	2.95	3.25	1.90	1.50	6.70	3.50	2.50	1.95	4.10	5.65	4.00	2.30
6	2.85	3.30	1.75	.80	6.50	3.25	4.10	1.83	6.00	5.55	4.20	2.20
7	2.75	3.30	1.70	.70	5.25	3.95	3.25	3.50	5.65	5.35	4.20	2.20
8	2.60	3.15	1.60	.70	4.40	4.55	2.65	5.65	6.35	5.05	4.05	2.20
9	3.35	3.10	1.60	.70	3.25	4.30	2.90	4.55	7.00	4.90	4.00	2.20
10	3.80	3.10	1.55	.65	2.85	4.25	2.60	3.54	7.55	4.90	4.00	2.20
11	3.85	3.25	1.50	.60	2.55	4.15	2.05	3.10	7.85	4.85	3.90	2.10
12	3.70	3.15	1.50	.60	2.25	3.90	1.95	2.85	7.60	4.65	3.80	2.10
13	3.30	3.15	1.25	.60	2.05	5.00	1.85	2.55	7.35	4.50	3.80	2.20
14	3.35	3.00	1.20	.60	2.00	4.55	1.65	2.40	7.20	4.40	3.75	2.20
15	3.70	3.05	1.20	.60	2.00	4.45	1.55	2.25	6.80	4.30	3.60	2.17
16	4.25	2.85	1.30	.60	3.65	3.55	1.50	2.95	5.80	4.25	3.45	2.20
17	4.25	2.95	1.75	.60	2.85	3.10	1.50	3.75	5.50	5.60	3.25	2.14
18	4.40	2.90	1.75	.60	2.85	2.85	1.51	3.70	5.50	9.50	3.05	2.10
19	4.40	2.90	1.80	.60	2.60	2.65	1.50	3.55	5.85	7.95	2.80	2.03
20	4.25	2.90	1.35	.60	2.35	2.80	1.90	3.30	5.90	6.15	2.66	2.00
21	4.15	3.00	1.00	.60	3.30	3.95	3.45	3.30	5.75	5.95	2.65	2.00
22	3.80	2.90	.90	.60	3.05	3.05	3.70	5.15	5.55	6.05	2.60	2.00
23	3.60	2.85	.95	.60	3.80	2.95	3.60	3.85	8.35	6.15	2.60	2.00
24	3.60	2.90	1.00	.60	3.85	2.55	2.70	3.40	7.55	6.00	2.45	2.00
25	3.45	2.60	1.00	.60	5.00	2.40	2.55	3.15	5.90	5.85	2.50	2.00
26	3.30	2.50	1.00	.50	6.45	2.45	2.45	2.95	5.35	5.55	2.40	2.00
27	3.25	2.50	.95	.50	7.10	2.25	2.95	2.50	5.45	5.35	2.40	2.00
28	3.35	2.50	.90	.50	6.90	2.10	2.80	2.10	6.05	5.00	2.40	2.00
29	3.20	.....	.90	.50	6.30	2.25	2.10	2.00	6.65	4.90	2.40	2.00
30	3.40	.....	.80	.50	6.10	2.10	2.23	2.00	6.95	4.55	2.40	2.00
31	3.45	.....	.80	.....	5.75	.....	3.20	1.90	.....	4.35	.....	2.00

Daily gage height, in feet, of Margueretta flume near Pecos, Texas, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	0.15	0.50	1.80	2.45	2.25	2.50	2.70	2.90	2.25	2.40	2.53
2	1.80	.15	.90	1.75	2.05	2.30	2.50	2.77	2.88	2.40	2.40	2.53
3	1.80	.10	1.35	1.70	2.35	2.25	2.52	2.70	2.87	2.40	2.40	2.53
4	1.80	.10	1.40	1.90	2.35	2.35	2.55	2.80	2.84	2.50	2.40	2.53
5	1.40	.10	1.40	2.25	2.35	2.35	2.60	2.79	2.90	2.38	2.45	2.53
6	.90	.10	1.40	1.95	2.35	2.40	2.68	2.78	2.95	2.38	2.50	2.52
7	.85	.10	1.40	1.55	2.30	2.45	2.68	2.88	2.90	2.40	2.50	2.59
8	.80	1.15	1.40	1.80	2.35	2.40	2.60	2.80	3.05	2.30	2.50	2.60
9	.95	1.00	1.40	1.90	2.10	2.40	2.60	2.80	3.10	2.35	2.50	2.60
10	.80	1.00	1.35	1.80	2.15	2.45	2.58	2.78	2.50	2.35	2.50	2.60
11	.65	1.00	1.30	1.80	2.10	2.40	2.45	2.80	1.95	2.30	2.50	2.60
12	.60	1.00	1.30	1.85	2.15	2.40	2.45	2.80	2.28	2.30	2.50	2.60
13	1.60	1.00	1.55	1.85	2.20	2.40	2.68	2.90	2.52	2.30	2.50	2.62
14	1.50	.90	1.60	1.90	2.10	2.40	2.60	2.88	2.60	2.35	2.51	2.60
15	1.40	.95	1.65	1.90	2.15	2.45	2.60	2.86	2.68	2.35	2.50	2.62
16	1.95	.95	1.45	1.95	2.45	2.30	2.56	2.90	2.55	2.38	2.45	2.62
17	1.80	1.05	.80	1.90	2.20	2.35	2.56	2.85	2.60	2.45	2.40	2.60
18	.35	1.20	.90	1.90	2.00	2.40	2.50	2.86	2.70	2.28	2.45	2.60
19	(a)	1.20	.90	1.90	2.15	2.45	2.50	2.84	1.72	2.30	2.45	2.60
20	.....	.90	1.40	1.85	2.30	2.45	2.58	2.85	2.00	2.38	2.48	2.68
21	.....	.60	1.85	1.90	2.35	2.40	2.75	2.82	2.20	2.38	2.50	2.68
22	.....	.60	1.80	1.80	2.30	2.40	2.80	2.90	2.55	2.38	2.50	2.68
23	.....	.55	1.80	1.90	2.30	2.50	2.72	2.85	2.50	2.40	2.50	2.66
24	.40	.60	1.80	1.90	2.35	2.40	2.60	2.91	2.24	2.35	2.50	2.62
25	.30	.60	1.90	1.90	2.25	2.40	2.70	2.88	2.30	2.38	2.50	2.66
26	.30	.60	1.80	1.90	2.05	2.45	2.32	2.90	2.38	2.35	2.50	2.70
27	.25	.60	1.80	1.90	2.40	2.45	2.55	2.90	2.60	2.38	2.50	2.70
28	.18	.60	1.80	1.90	2.45	2.50	2.80	2.98	2.65	2.30	2.50	2.70
29	.10	.....	1.70	1.80	2.50	2.50	2.65	2.90	2.60	2.30	2.52	2.70
30	.15	.....	1.70	1.75	2.50	2.50	2.62	2.90	2.42	2.45	2.52	.....
31	.15	.....	1.75	.....	2.45	.....	2.72	2.90	.....	2.40	.....	.....

a No water in flume.

TOYAH CREEK, TEXAS.

Toyah Creek rises in natural springs about 40 miles southwest of Pecos, Texas. These springs are mainly in section 256, patented by the State of Texas to Antonio Ball. They are in a flat valley hemmed in by a horseshoe curve of the Davis Mountains. About 3 miles to the northwest is Phantom Lake. It is stated by close observers that the water of this lake is of the same composition and general character as that of the Toyah Springs, and it is probable that the lake is on the underground stream that issues from the earth in the springs. The largest of the Toyah Springs is oval shaped, about 100 feet long by 60 feet broad. Its water level is influenced by the weeds and long grass which grow in it, also by the atmosphere. As measured on September 5, 1900, by Thomas U. Taylor, the entire discharge was 46 second-feet. A large percentage of the water is deflected into the ditch of the Toyah Creek Irrigation Company. The flow of the spring is equal to about 8 heads; a head being defined as the amount of water flowing through an opening 1 foot square the upper edge of which is 4 inches below the water surface. There is an unverified and hazy tradition that the flow once amounted to 12 heads, but this is doubted. The springs are about an eighth of a mile east of the post-office at Toyahvale. La Loma is about 1 mile below the head spring, on the right bank. India (known as Brogado post-office) is about 4 miles below the springs, on the right bank, while Saragossa is 9 miles below the head spring, on the right bank of the creek.

For several miles the creek skirts the foothills of the Davis Mountains, and, in addition to the well-known springs mentioned it is fed by small invisible springs and by seepage. It empties into Toyah Lake, a large, flat depression charged with alkali, about 35 miles from Toyahvale and about 12 miles south of Pecos.

A half mile above Saragossa, on the main Saragossa ditch, is the Clements grain and flour mill, a building constructed of adobe and timber, where there is a fall of 12 feet. The principal irrigation ditch leading from the largest of the Toyah Springs (now known as the Clements or Murphy ditch) was projected as early as 1875, but the ditches of the Saragossa and Toyah Creek companies were chartered in 1875 and 1876. Afterwards the companies passed through various ownerships and changes, until 1894, when Mr. E. Clements obtained all of the rights and titles of the Saragossa ditch, and in 1895 a controlling interest in the Toyah Creek ditch. The Saragossa ditch diverts water from Toyah Creek about 6¼ miles below the Toyah Springs and about 1¾ miles above the town of Saragossa. Both ditches are now operated under the Clements management, being connected by a lateral. The original Saragossa ditch was constructed probably as early as 1869, at a point where the bed of the creek ended in rather swampy lands. These lands are now in the Saragossa farm. From the best evidence obtainable, the flow of the Saragossa Spring was formerly about 15 second-feet, and it was the largest affluent of Toyah Creek below section 256 (Toyah Spring). No dam is used at the head of the Saragossa ditch, the bottom of the ditch being low enough to drain the creek.

In all there are five ditches diverting water from Toyah Creek, as follows: (1) Clements (or Murphy) ditch, 9 miles long, taken out of Toyah Springs on the south side, and irrigating about 1,500 acres; (2) the Giffin ditch, 1 mile long, taken out of Toyah Creek on the north side, and irrigating about 400 acres; (3) the Saragossa ditch (included in the Clements system), 2 miles long, taken out on the south side of the creek about 6 miles below Toyah Springs, and irrigating 1,500 acres; (4) the St. Isabella ditch, 2 miles long, taken out on the north side of the creek 19 miles below Toyah Springs, and irrigating about 60 acres (the creek at this place usually has no flow, the water for irrigation being obtained from springs); (5) the Pruett ditch, 2 miles long, head gate 26 miles below Toyah Springs, taken out on the south side, and irrigating about 300 acres. The crops raised are mostly corn, wheat, kaffir corn, and sweet potatoes. From Toyahvale to Saragossa the irrigation has been very effective.

PECOS RIVER NEAR MOORHEAD, TEXAS.

This station was established in April, 1900, by the International (Water) Boundary Commission. It is near Moorhead, immediately

above the high bridge of the Southern Pacific Railway. During 1900 the following measurements of discharge were made:

Discharge measurements of Pecos River near Moorhead, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 14	2.30	930	September 4	1.25	305
May 17	1.90	655	September 8	1.10	259
May 23	2.00	746	September 13	2.25	931
May 30	1.90	795	September 19	2.90	1,475
June 2	2.90	1,557	September 23	4.20	2,478
June 7	2.30	1,017	September 28	2.95	1,486
June 11	1.70	648	October 3	2.90	1,445
June 16	1.90	767	October 9	3.10	1,589
June 19	2.10	908	October 12	2.50	1,298
June 28	1.45	484	October 20	2.00	993
July 3	1.40	469	October 23	3.10	1,859
July 6	1.30	463	October 28	2.90	1,764
July 10	1.20	362	November 1	2.80	1,315
July 13	1.50	516	November 5	2.20	980
July 17	9.25	9,265	November 9	2.10	877
July 18	1.70	587	November 18	2.00	783
July 23	1.20	314	November 19	1.90	702
July 27	1.10	302	November 27	1.70	589
July 31	1.50	440	December 1	1.65	542
August 4	1.50	443	December 7	1.60	532
August 10	1.60	495	December 11	1.55	509
August 14	2.10	835	December 15	1.55	535
August 18	1.50	467	December 19	1.50	477
August 23	1.30	374	December 24	1.50	440
August 27	1.40	424	December 30	1.50	442
August 31	1.40	404			

Daily gage height, in feet, of Pecos River near Moorhead, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.65	2.80	1.50	1.50	1.50	3.35	2.85	1.60
2	1.90	2.95	1.45	1.50	1.40	3.00	2.75	1.60
3	1.65	2.80	1.40	1.50	1.30	2.90	2.55	1.60
4	1.50	2.80	1.40	1.50	1.30	2.90	2.45	1.60
5	1.50	2.70	1.35	1.50	1.40	2.90	2.25	1.60
6	1.40	2.55	1.30	1.50	1.35	2.80	2.20	1.60
7	1.40	2.25	1.30	1.55	1.20	2.70	2.20	1.60
8	1.50	2.05	1.30	1.80	1.10	3.25	2.10	1.60
9	2.10	1.90	1.30	1.85	1.10	3.05	2.10	1.60
10	2.85	1.80	1.20	1.60	1.10	2.85	2.10	1.60
11	2.75	1.70	1.20	1.55	1.10	2.65	2.00	1.60
12	2.55	1.70	1.35	1.50	1.50	2.45	2.20	1.60
13	2.35	1.90	1.50	1.40	2.25	2.25	2.00	1.60
14	2.20	1.90	1.50	2.10	2.50	2.20	2.10	1.60
15	2.10	1.90	1.45	2.05	2.25	2.20	2.20	1.60
16	2.00	1.90	1.30	1.95	2.80	2.15	2.10	1.50
17	1.90	1.90	5.80	1.65	2.90	2.10	2.00	1.50
18	1.85	1.80	1.75	1.50	3.00	2.10	1.95	1.50
19	1.75	2.00	1.45	1.50	2.90	2.10	1.90	1.50
20	1.60	2.00	1.40	1.45	2.85	2.00	1.80	1.50
21	4.70	2.00	1.40	1.40	2.75	2.15	1.75	1.50
22	2.25	1.85	1.30	1.30	2.60	2.80	1.80	1.50
23	2.05	1.70	1.20	1.25	3.85	3.10	1.90	1.50
24	2.00	1.60	1.20	1.25	2.95	3.35	1.80	1.50
25	1.90	1.50	1.20	1.40	2.75	3.25	1.80	1.50
26	1.85	1.40	1.20	2.15	2.60	3.15	1.80	1.50
27	1.80	1.40	1.10	1.40	2.60	2.95	1.70	1.50
28	1.70	1.45	1.20	1.40	3.15	3.10	1.70	1.50
29	1.80	1.50	1.35	1.40	2.95	3.80	1.60	1.50
30	1.95	1.50	1.45	1.40	3.05	3.35	1.60	1.50
31	2.30	.....	1.50	1.40	.....	3.05	.....	1.50

DEVILS RIVER AT DEVILSRIVER, TEXAS.

This station was established in April, 1900, by the International (Water) Boundary Commission. It is opposite the Southern Pacific Railway station at Devilsriver. The river is about 50 miles in length,

has a perennial flow, and during flood periods is subject to great fluctuations. During 1900 the following measurements of discharge were made:

Discharge measurements of Devils River at Devilsriver, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
May 20	2.80	1,175	August 14	2.90	1,084
May 24	3.35	1,458	August 20	2.70	955
May 30	3.00	1,262	August 23	2.65	902
June 4	2.90	1,200	August 27	2.60	859
June 7	2.80	1,060	August 31	2.60	841
June 11	2.80	1,049	September 6	2.70	982
June 15	2.80	994	September 10	2.65	864
June 19	2.80	1,000	September 14	2.50	781
June 23	2.70	917	September 20	2.50	747
June 27	2.70	896	September 24	10.25	26,386
June 29	8.20	13,493	October 3	2.90	1,131
July 3	2.95	1,171	October 9	2.80	1,063
July 6	2.80	895	October 22	3.00	1,274
July 10	2.70	918	November 2	3.30	1,592
July 14	2.65	908	November 6	2.80	1,040
July 19	2.70	948	November 14	2.70	937
July 23	2.60	858	November 23	2.70	948
July 27	2.60	891	December 4	2.50	862
July 31	2.60	900	December 7	2.60	911
August 4	2.70	997	December 13	2.60	901
August 7	2.65	944	December 18	2.60	897
August 11	3.10	1,311	December 29	2.50	831

Daily gage height, in feet, of Devils River at Devilsriver, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.95	3.00	3.20	2.65	2.70	3.00	4.25	2.60
2	2.80	2.90	3.20	2.70	2.70	2.90	3.75	2.60
3	2.80	2.90	2.90	2.80	2.70	2.90	3.30	2.60
4	2.80	2.90	2.90	2.75	2.70	2.90	3.00	2.60
5	2.80	2.90	2.90	2.65	2.70	2.80	2.95	2.60
6	2.80	2.85	2.90	2.60	2.70	2.80	2.80	2.60
7	2.85	2.85	2.80	2.60	2.70	2.80	2.80	2.60
8	2.80	2.80	2.80	4.60	2.70	2.80	2.80	2.60
9	2.80	2.80	2.80	4.35	2.70	2.80	2.80	2.60
10	2.80	2.80	2.80	3.45	2.60	2.90	2.80	2.60
11	2.75	2.80	2.80	3.15	2.60	3.00	2.80	2.60
12	2.75	2.80	2.80	2.95	2.60	3.00	2.80	2.60
13	2.80	2.80	2.70	2.90	2.60	3.00	2.80	2.60
14	3.25	2.80	2.70	2.90	2.55	3.00	2.70	2.60
15	4.00	2.80	2.65	2.90	2.50	3.00	2.70	2.60
16	3.10	2.80	2.70	2.85	2.50	3.00	2.60	2.60
17	2.90	2.80	2.70	2.80	2.50	3.00	2.60	2.60
18	2.90	2.80	2.70	2.80	2.50	3.00	2.70	2.60
19	2.90	2.75	2.70	2.80	2.50	3.00	2.70	2.50
20	2.90	2.80	2.70	2.75	2.50	3.00	2.70	2.50
21	3.75	2.75	2.70	2.75	2.50	3.00	2.70	2.50
22	5.35	2.75	2.70	2.70	10.60	3.00	2.70	2.50
23	3.45	2.80	2.60	2.70	15.25	3.00	2.70	2.50
24	3.35	2.80	2.55	2.70	11.00	3.00	2.70	2.50
25	3.20	2.80	2.55	2.70	6.20	3.00	2.60	2.50
26	3.10	2.80	2.80	2.70	5.05	3.00	2.60	2.50
27	3.05	2.80	2.60	2.60	4.35	3.00	2.60	2.50
28	3.00	2.80	2.60	2.60	3.40	3.00	2.60	2.50
29	3.00	8.25	2.65	2.60	3.00	3.00	2.60	2.50
30	3.00	4.55	2.75	2.60	3.00	3.00	2.60	2.50
31	3.00	.....	2.65	2.60	.....	3.90	.....	2.50

RIO GRANDE NEAR DEVILSRIVER, TEXAS.

This station was established in April, 1900, by the International (Water) Boundary Commission. It is alongside the Southern Pacific Railway track, about a half mile below the mouth of Devils River

and about 480 miles below El Paso. During 1900 the following measurements of discharge were made:

Discharge measurements of Rio Grande near Devilsriver, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 25	4.90	5,586	September 6	8.50	18,012
May 31	3.90	3,303	September 11	4.30	4,261
June 4	4.45	5,062	September 15	5.30	6,643
June 8	4.20	4,054	September 21	4.50	4,531
June 12	3.90	3,543	September 25	7.60	13,457
June 15	4.60	5,101	October 4	5.80	7,552
June 20	4.10	3,930	October 10	5.00	5,460
June 23	4.10	3,725	October 14	4.70	4,428
June 27	3.70	2,826	October 22	5.00	5,343
June 30	4.70	4,948	October 25	5.00	5,364
July 4	4.20	3,848	October 27	4.70	4,519
July 7	4.40	5,009	November 3	4.50	4,013
July 13	6.40	10,478	November 7	4.25	3,346
July 20	4.90	5,612	November 10	4.20	3,288
July 24	5.55	7,692	November 15	4.05	2,990
July 28	5.90	9,151	November 20	4.00	2,911
August 1	6.70	10,917	November 24	3.95	2,770
August 7	6.45	10,609	November 28	3.85	2,655
August 11	7.75	14,735	December 4	3.80	2,562
August 15	6.10	8,854	December 8	3.75	2,435
August 20	6.00	8,971	December 13	3.75	2,465
August 24	5.25	6,653	December 18	3.75	2,419
August 28	5.20	6,205	December 23	3.70	2,346
September 1	4.75	5,277	December 29	3.65	2,348

Daily gage height, in feet, of Rio Grande near Devilsriver, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	4.20	3.95	6.75	4.65	5.25	4.85	3.80
2	3.60	4.70	4.05	6.90	5.95	4.70	4.60	3.80
3	3.50	5.60	3.70	6.90	4.60	5.00	4.45	3.80
4	3.50	4.40	4.10	6.75	5.00	5.70	4.40	3.80
5	3.30	4.35	4.60	8.70	6.80	5.60	4.40	3.80
6	3.35	4.30	4.65	7.45	8.50	5.45	4.30	3.80
7	3.55	4.45	4.40	6.35	5.80	5.25	4.30	3.80
8	3.60	4.15	4.40	9.45	4.30	5.10	4.30	3.80
9	3.80	3.85	4.40	10.50	3.95	5.00	4.25	3.80
10	3.90	3.75	3.75	9.65	3.90	5.00	4.20	3.80
11	3.80	3.75	3.60	7.70	4.35	5.00	4.20	3.80
12	3.80	3.90	3.60	7.10	4.35	4.85	4.20	3.80
13	3.65	3.95	5.75	6.70	4.65	4.80	4.20	3.80
14	3.90	3.85	7.10	6.40	5.70	4.65	4.10	3.80
15	4.45	4.65	6.30	6.10	5.15	4.45	4.05	3.80
16	3.80	4.45	6.45	5.55	5.00	4.40	4.00	3.80
17	3.70	4.35	6.60	5.45	4.95	4.40	4.00	3.80
18	3.60	4.50	6.35	5.20	4.85	4.35	4.00	3.80
19	3.60	4.60	5.15	5.00	4.70	4.55	4.00	3.70
20	3.50	4.20	4.80	6.10	4.60	5.40	4.00	3.70
21	4.10	3.95	4.40	6.30	4.50	6.25	4.00	3.70
22	6.15	3.85	4.40	5.80	9.90	5.00	4.00	3.70
23	6.15	3.95	5.60	5.90	16.60	4.75	4.00	3.70
24	4.70	3.85	5.25	5.15	12.25	5.00	4.00	3.70
25	4.80	3.60	4.50	4.90	7.10	5.00	3.85	3.70
26	4.35	3.40	4.75	4.85	5.60	4.85	3.80	3.70
27	4.05	3.60	5.95	5.55	5.00	4.70	3.80	3.70
28	4.00	3.50	5.75	5.20	4.80	4.50	3.80	3.70
29	3.90	8.75	5.70	4.55	6.80	4.50	3.80	3.70
30	3.80	4.65	6.30	4.75	6.10	4.50	3.80	3.70
31	3.80	.....	6.35	4.55	.....	5.25	.....	3.70

RIO GRANDE NEAR EAGLE PASS, TEXAS.

This station was established in April, 1900, by the International (Water) Boundary Commission. It is a half mile above the railway bridge between Eagle Pass and Ciudad Porfirio Diaz, Mexico, and

about 540 miles below El Paso, Texas. During 1900 the following measurements of discharge were made:

Discharge measurements of Rio Grande near Eagle Pass, Texas.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 27	4.20	7,321	September 11	3.90	6,505
May 30	3.80	5,182	September 14	4.55	10,138
June 6	3.90	6,098	September 29	4.50	13,851
June 8	3.80	5,867	October 2	4.40	12,307
June 11	3.70	4,900	October 5	4.80	12,320
June 15	3.90	6,030	October 8	4.20	8,900
June 18	4.30	6,743	October 15	3.80	6,599
June 21	3.80	5,329	October 23	4.20	7,674
June 22	3.60	4,794	October 25	4.10	6,895
June 25	3.70	5,042	October 26	4.20	7,333
June 29	3.50	4,519	October 29	3.90	6,748
July 2	3.70	4,451	November 5	3.60	5,759
July 6	3.80	4,994	November 7	3.40	5,618
July 9	4.00	5,839	November 12	3.20	5,924
July 13	4.20	7,401	November 16	3.20	4,837
July 14	5.55	16,111	November 19	3.30	5,765
July 16	5.80	16,733	November 21	3.30	4,830
July 23	3.90	5,766	November 21	3.30	4,781
July 30	4.80	10,359	November 26	3.20	4,877
August 3	5.30	12,524	November 28	3.20	4,729
August 6	6.30	17,026	November 30	3.10	4,859
August 20	4.50	8,187	December 4	3.10	4,468
August 23	4.85	9,353	December 5	3.10	4,532
August 27	4.20	6,556	December 11	3.10	4,379
August 31	4.10	6,369	December 27	2.90	3,454
September 3	4.40	7,689			

Daily gage height, in feet, of Rio Grande near Eagle Pass, Texas, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	3.80	3.75	5.40	5.15	5.05	3.80	3.20
2	3.55	3.80	3.70	5.30	4.00	4.70	4.00	3.20
3	3.45	3.75	3.75	5.20	4.45	4.90	3.80	3.20
4	3.35	4.65	3.90	5.65	4.00	4.95	3.65	3.10
5	3.25	4.15	4.00	5.50	4.40	4.70	3.60	3.10
6	3.20	3.90	4.30	6.15	6.20	4.45	3.50	3.10
7	4.00	4.00	4.10	5.70	5.30	4.50	3.50	3.10
8	3.50	3.80	4.00	5.90	4.20	4.40	3.45	3.10
9	3.20	4.10	3.70	9.75	3.90	4.35	3.40	3.10
10	3.35	3.70	3.45	7.90	3.70	4.30	3.50	3.10
11	3.50	3.70	3.45	7.35	3.60	4.20	3.45	3.10
12	3.50	3.70	3.85	6.60	3.90	4.15	3.40	3.10
13	3.50	3.65	4.20	6.05	4.10	4.00	3.35	3.10
14	7.40	3.80	5.55	5.65	4.60	3.95	3.30	3.10
15	10.50	3.95	5.85	5.45	4.55	3.85	3.40	3.10
16	6.55	4.00	5.80	5.20	4.40	3.85	3.35	3.10
17	4.80	4.50	5.35	4.90	4.35	3.90	3.30	3.05
18	4.30	4.35	5.30	4.85	4.25	4.50	3.30	3.00
19	4.30	3.80	4.70	4.60	4.00	4.15	3.30	3.00
20	4.20	3.70	4.35	4.50	4.05	4.95	3.30	3.00
21	4.20	3.80	4.05	5.15	3.90	5.30	3.30	2.95
22	5.30	3.60	3.90	5.20	5.80	4.45	3.30	2.90
23	5.10	3.60	3.90	5.00	11.70	4.15	3.30	2.95
24	5.05	3.60	3.90	4.90	10.80	4.05	3.25	3.00
25	4.95	3.65	3.80	4.35	9.95	4.05	3.20	3.00
26	4.55	3.40	4.10	4.20	6.10	4.45	3.20	2.90
27	4.15	3.10	4.65	4.30	5.45	4.05	3.20	2.90
28	3.90	3.90	4.95	4.55	4.90	4.20	3.20	2.90
29	3.85	3.40	4.80	4.45	4.65	3.95	3.20	2.90
30	3.80	6.00	4.75	4.30	5.20	3.90	3.20	2.90
31	3.80	.....	5.15	4.10	.....	4.05	.....	2.90

GREEN RIVER AT GREENRIVER, WYOMING.

This station was established May 2, 1895. It is at the pump house of the Union Pacific Railway Company. A description of the station was published in Water-Supply Paper No. 37, page 286. Results of

measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 302. The station was discontinued March 31, 1900. No measurements of discharge were made during the year.

Daily gage height, in feet, of Green River at Greenriver, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	1.65			12		1.60	1.20	23	1.75		
2		1.65	1.50	13	1.85			24		1.45	1.35
3	1.70			14		1.55	1.25	25	1.75		
4		1.65	1.55	15	1.85			26		1.45	1.40
5	1.75			16		1.55	1.30	27	1.70		
6		1.60	1.65	17	1.85			28		1.50	1.50
7	1.80			18		1.55	1.30	29	1.70		
8		1.60	1.50	19	1.85			30			1.60
9	1.80			20		1.50	1.30	31	1.65		
10		1.60	1.20	21	1.80						
11	1.85			22		1.50	1.30				

BLACK FORK OF GREEN RIVER NEAR GRANGER, WYOMING.

This station, established April 28, 1897, is below the mouth of Hams Fork. It is described in Water-Supply Paper No. 37, page 287. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 303. During 1900 the following measurements were made by A. J. Parshall:

May 3: Gage height, 1.45 feet; discharge, 778 second-feet.
May 15: Gage height, 2.85 feet; discharge, 1,969 second-feet.
June 7: Gage height, 2.20 feet; discharge, 1,455 second-feet.
June 20: Gage height, 0.85 foot; discharge, 468 second-feet.
July 4: Gage height, 0.13 foot; discharge, 75 second-feet.
July 28: Gage height, —0.20 foot; discharge, 27 second-feet.

Daily gage height, in feet, of Black Fork of Green River near Granger, Wyoming, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1				0.65	1.75	2.95	0.20	—0.20	*a*—0.20
2				.70	1.70	2.90	.20	— .20	
3		1.20	1.70	.75	1.45	2.50	.15	— .20	
4				.75	1.50	2.45	.10	— .20	
5				.85	1.55	2.20	.10	— .20	
6	1.30			1.00	1.65	2.20	.05	— .20	
7				1.00	1.80	2.30	.00	— .20	(*a*)
8				1.00	1.90	2.15	.00	— .20	(*a*)
9				1.35	2.00	2.05	.00	— .20	(*a*)
10		1.60	1.80	1.35	2.25	2.05	.00	— .20	(*a*)
11			1.95	1.25	2.60	1.85	.00	— .20	(*a*)
12			2.60	1.20	2.90	1.70	.00	— .20	(*a*)
13	1.30		2.80	1.00	2.95	1.60	—.10	— .20	(*a*)
14			2.05	1.00	2.90	1.50	—.20	— .20	(*a*)
15			1.35	1.00	2.55	1.40	—.20	*a*— .20	(*a*)
16			1.25	1.00	2.50	1.25	—.20	*a*— .20	(*a*)
17		1.60	1.35	.90	2.60	1.10	—.20	*a*— .20	(*a*)
18				.90	2.70	1.00	—.20	*a*— .20	(*a*)
19				.90	2.70	1.00	—.30	*a*— .20	(*a*)
20	1.30			1.05	2.70	.95	—.30	*a*— .20	(*a*)
21				1.20	2.45	.85	—.30	*a*— .20	(*a*)
22				1.30	2.55	.75	—.20	*a*— .20	(*a*)
23				1.30	2.55	.70	—.20	*a*— .20	(*a*)
24		1.80	.90	1.30	2.85	.65	—.10	*a*— .20	(*a*)
25				1.25	2.95	.60	.00	*a*— .20	
26				1.20	2.95	.65	—.05	*a*— .20	
27	1.30			1.30	3.00	.65	—.10	*a*— .20	
28				1.30	3.35	.55	—.20	*a*— .20	(*a*)
29				1.30	3.40	.35	—.20	*a*— .20	(*a*)
30				1.60	3.25	.25	—.20	*a*— .20	(*a*)
31			.70		3.05		—.20	*a*— .20	

a Water standing in pools.

ASHLEY CREEK NEAR VERNAL, UTAH.

This stream drains an area directly east of the Uinta Basin. About 7½ miles above the town of Vernal the river appears from its canyon, and within the next few miles a series of canals divert its low-water flow, which is applied to the adjacent lands—Vernal Valley—which are extensively irrigated. This valley is described in detail in the Twenty-first Annual Report, Part IV, pages 311 to 313. A gaging station was established in the canyon of this stream on March 15, 1900, by C. T. Prall. It is located at the ranch of the observer, E. Marett. The gage is a vertical rod, painted white, fastened to the west side of the single pier of the wagon bridge. The bench mark is a 20-penny nail driven in the pier opposite the 4-foot mark. The channel is straight for a distance above and below the bridge, and the bed is rocky. At high stages two other channels discharge a portion of the water, and these also have to be measured.

The three principal canals diverting water from Ashley Creek below the gaging station are, in order downstream, Upper Ashley canal, Rock Point canal, and Central Ashley canal. During the season of 1900 they were measured twice by C. C. Babb, with the following results:

Discharge measurements of canals diverting water from Ashley Creek.

Date.	Upper Ashley canal.	Rock Point canal.	Central Ashley canal.
1900.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
May 29	181	25.0	138
August 21	*a* 12	6.8	*a* 10

a At measuring weir.

On October 30, 1900, Ashley Creek was measured by A. L. Fellows at its mouth, near Jensen, Utah, and a discharge of 11 second-feet was found. During the year the following measurements were made at the regular station in the canyon by C. T. Prall and others:

Discharge measurements of Ashley Creek near Vernal, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
February 8	.....	34	July 23	0.67	72
March 15	0.48	37	Do	.67	83
May 1	.62	45	August 21	.60	40
May 28	3.20	776	November 12	.55	47
June 11	1.74	306			

Daily gage height, in feet, of Ashley Creek near Vernal, Utah, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.48	0.60	2.45	0.95	0.65	0.55	0.70	0.60	0.55
2	.....	.48	.65	2.40	.95	.65	.55	.65	.60	.55
3	.....	.49	.63	2.25	.90	.65	.50	.65	.60	.55
4	.....	.50	.70	2.40	.90	.65	.50	.65	.60	.55
5	.....	.49	.98	2.00	.90	.65	.50	.60	.60	.55
6	.....	.49	1.20	1.85	.90	.65	.50	.60	.60	.55
7	.....	.48	1.20	1.70	.90	.65	.50	.60	.55	.55
8	.....	.49	1.50	1.65	.85	.65	.50	.65	.55	.55
9	.....	.53	2.20	1.70	.85	.65	.50	.60	.55	.55
10	.....	.50	2.50	1.70	.85	.65	.58	.60	.55	.55
11	.....	.50	2.85	1.75	.85	.65	.65	.60	.55	.55
12	.....	.50	2.50	1.65	.85	.60	.60	.60	.55	.55
13	.....	.50	2.25	1.55	.85	.60	.60	.60	.55	.55
14	.....	.50	2.05	1.50	.85	.60	.55	.60	.55	.55
15	.....	.50	2.20	1.45	.85	.55	.55	.60	.55	.50
16	.....	.50	2.50	1.43	.85	.55	.55	.60	.55	.50
17	.....	.50	2.50	1.40	.85	.55	.55	.60	.55	.50
18	0.48	.50	2.45	1.35	.80	.55	.55	.60	.60	.50
19	.48	.50	2.30	1.20	.80	.55	.55	.60	.60	.50
20	.48	.50	2.20	1.20	.75	.55	.55	.60	.60	.50
21	.48	.50	2.35	1.20	.75	.60	.55	.60	.60	.50
22	.49	.53	2.60	1.20	.70	.60	.60	.60	.65	.50
23	.50	.63	3.00	1.15	.70	.60	.60	.60	.65	.50
24	.50	.60	3.20	1.10	.70	.60	.75	.60	.65	.50
25	.49	.60	3.25	1.05	.70	.60	.70	.60	.60	.50
26	.49	.60	3.30	1.00	.70	.60	.65	.60	.60	.50
27	.48	.60	3.45	1.00	.70	.60	.70	.60	.60	.50
28	.48	.60	3.35	1.00	.70	.60	.70	.60	.55	.50
29	.48	.65	3.15	1.00	.70	.60	.65	.60	.55	.50
30	.48	.65	2.80	1.00	.70	.60	.65	.60	.55	.50
31	.48	.....	2.65	.....	.70	.60	.....	.60	.....	.50

UINTA RIVER NEAR WHITEROCKS, UTAH.

This station, established by C. C. Babb on September 16, 1899, is described in Water-Supply Paper No. 37, page 288. During 1900 daily records were not kept at this place, but frequent measurements of discharge were made by C. T. Prall and others, as follows:

Discharge measurements of Uinta River near Whiterocks, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 3	*a* 1.05	114	June 22	1.50	418
January 8	*a* .90	105	June 29	1.33	341
January 16	*a* .92	113	July 7	1.20	250
January 22	*a* 1.00	116	July 12	1.10	224
January 30	*a* 1.05	114	July 20	1.04	196
February 5	*a* .90	112	August 9	1.05	182
February 12	*a* .83	106	August 21	1.02	186
February 19	*a* 1.02	117	September 4	1.04	165
February 26	.84	115	September 17	.96	150
March 5	.85	121	October 9	1.00	163
March 12	.89	130	October 29	.95	145
March 19	.80	120	November 5	.90	128
March 26	.87	130	November 19	.90	136
April 9	.92	144	November 26	.95	150
April 16	.86	132	December 3	1.05	170
May 22	2.30	1,162	December 11	*a* 1.00	134
June 1	2.20	1,059	December 17	*a* 1.00	143
June 8	1.81	691	December 24	*a* .95	133
June 15	1.60	477			

a Gage height doubtful on account of ice.

WHITEROCKS RIVER NEAR WHITEROCKS, UTAH.

This station was established September 15, 1899, by C. C. Babb, in connection with the investigation of the water supply for the Uinta Indian Reservation. It is in the canyon of the river, about 10 miles

above the Indian agency at Whiterocks, and is described in Water-Supply Paper No. 37, page 289. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, pages 322, 323, and 324. Daily gage readings were not maintained during 1900, but frequent measurements of discharge were made by C. T. Prall and others, as follows:

Discharge measurements of Whiterocks River near Whiterocks, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 4	a 0.95	50	June 7	1.80	290
January 9	a .95	46	June 16	1.60	194
January 17	a .93	46	June 23	1.52	166
January 23	a .90	49	June 30	1.33	125
January 31	a .90	44	July 6	1.22	98
February 13	a 1.00	46	July 13	1.16	79
February 20	a .96	44	July 21	1.10	69
February 27	1.00	53	August 10	1.10	58
March 6	1.00	59	August 22	1.10	66
March 13	.80	49	September 5	1.10	59
March 20	.82	47	September 18	1.04	52
March 27	.88	45	October 10	1.05	65
April 10	.86	41	October 30	.88	49
April 17	.92	47	November 6	.95	61
May 23	2.80	730	November 20	.95	57
June 2	2.20	488			

a Gage height doubtful on account of ice.

UINTA RIVER AT FORT DUCHESNE, UTAH.

This station, established by C. C. Babb on September 14, 1899, is at the highway bridge at the military post. It is described in Water-Supply Paper No. 37, page 290. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, pages 322, 323, and 324. During 1900 the following measurements of discharge were made by C. T. Prall and others:

Discharge measurements of Uinta River at Fort Duchesne, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 5	a 2.56	129	June 13	3.30	420
January 11	a 2.50	118	June 18	3.05	284
January 19	a 2.60	132	June 25	2.98	197
January 25	a 2.55	123	July 2	2.76	170
February 2	a 2.55	119	July 2	2.76	169
February 10	a 2.60	101	July 9	2.59	114
February 15	a 2.56	115	July 17	2.30	58
February 22	2.67	143	July 25	2.44	68
March 2	2.77	149	August 4	2.21	19
March 8	2.85	173	August 17	2.18	25
March 14	2.61	137	August 28	2.27	34
March 21	2.42	84	September 11	2.58	91
March 28	2.37	62	October 8	2.62	95
April 12	2.43	76	October 26	2.64	103
April 18	2.39	72	November 3	2.63	101
April 27	2.41	72	November 10	2.62	97
May 3	2.48	90	November 17	2.65	103
May 14	3.17	376	November 24	2.74	114
May 16	3.69	798	November 29	2.61	94
May 18	3.98	1,202	December 8	2.65	95
May 21	3.87	1,045	December 15	2.65	103
May 24	4.35	1,972	December 22	2.65	100
May 31	4.14	1,254	December 26	2.60	91
June 9	3.46	501			

a Gage height doubtful on account of ice.

Daily gage height, in feet, of Uinta River at Fort Duchesne, Utah, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	2.42	2.54	3.98	2.77	2.21	2.20	2.63	2.63	2.70
2	(a)	2.41	2.51	3.85	2.75	2.20	2.22	2.68	2.65	2.70
3	(a)	2.44	2.48	3.78	2.78	2.20	2.23	2.69	2.65	2.70
4	2.78	2.49	2.45	3.71	2.75	2.20	2.35	2.63	2.65	2.70
5	2.77	2.54	2.48	3.63	2.72	2.35	2.45	2.60	2.65	2.63
6	2.74	2.55	2.53	3.59	2.62	2.47	2.43	2.55	2.61	2.68
7	2.78	2.54	2.52	3.53	2.60	2.43	2.40	2.55	2.64	2.58
8	2.86	2.53	2.55	3.47	2.60	2.40	2.39	2.60	2.64	2.60
9	2.80	2.53	2.60	3.45	2.59	2.39	2.40	2.60	2.65	2.63
10	2.68	2.52	2.76	3.39	2.54	2.33	2.48	2.60	2.65	2.70
11	2.67	2.46	3.10	3.43	2.48	2.25	2.50	2.60	2.65	2.65
12	2.66	2.46	3.38	3.43	2.43	2.25	2.53	2.60	2.65	2.60
13	2.63	2.47	3.25	3.33	2.40	2.25	2.50	2.60	2.65	2.50
14	2.61	2.47	3.20	3.20	2.38	2.25	2.44	2.50	2.65	2.40
15	2.58	2.46	3.26	3.17	(b)	2.25	2.44	2.58	2.65	2.40
16	2.57	2.43	3.67	3.10	.....	2.19	2.43	2.65	2.65	2.50
17	2.56	2.41	3.89	3.08	.....	2.17	2.42	2.65	2.65	2.50
18	2.53	2.40	4.42	3.04	.....	2.17	2.42	2.70	2.65	2.60
19	2.52	2.40	3.97	3.01	.....	2.20	2.42	2.70	2.70	2.60
20	2.47	2.40	3.89	2.98	.....	2.22	2.43	2.70	2.70	2.60
21	2.44	2.44	3.84	2.99	.....	2.27	2.44	2.68	2.75	2.80
22	2.42	2.41	4.05	2.95	.....	2.30	2.45	2.65	2.80	2.60
23	2.41	2.43	4.20	2.94	.....	2.30	2.50	2.68	2.80	2.50
24	2.41	2.41	4.33	3.00	.....	2.30	2.68	2.68	2.75	2.40
25	2.41	2.40	4.26	2.98	.....	2.30	2.74	2.65	2.75	2.50
26	2.42	2.39	4.38	2.93	.....	2.32	2.74	2.65	2.70	2.60
27	2.43	2.41	4.50	2.85	.....	2.32	2.60	2.65	2.67	2.60
28	2.38	2.44	4.53	2.87	.....	2.31	2.53	2.65	2.65	2.60
29	2.38	2.60	4.38	2.82	2.30	2.30	2.52	2.65	2.61	2.60
30	2.42	2.61	4.17	2.80	2.24	2.29	2.52	2.65	2.60	.....
31	2.43	.....	4.09	.....	2.22	2.25	.....	2.65	.....	.....

a Frozen. *b* No record July 15 to 28.

During the year two of the largest canals diverting water from Uinta River in this locality, known, respectively, as Canal No. 1 and Bench ditch, both heading above Fort Duchesne, were measured twice, with the following results:

Discharge measurements of canals above Fort Duchesne.

Date.	Canal No. 1.		Bench ditch.	
	Gage height.	Discharge.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
June 9	1.10	31	1.10	39
October 10	.8	9	.70	22

UINTA RIVER AT OURAY SCHOOL, UTAH.

This station, established November 8, 1899, is at the highway bridge over the river near the Ouray School, on the Uinta Indian Reservation. It is described in Water-Supply Paper No. 37, page 291. Results of measurements for 1899 will be found in the Twenty-first Annual

Report, Part IV, pages 322 and 324. During 1900 the following measurements of discharge were made by C. T. Prall and others.

Discharge measurements of Uinta River at Ouray School, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
March 9	0.80	181	August 17	−0.17	31
March 22	.31	83	August 28	.00	46
March 29	.26	58	September 11	.95	210
April 13	.34	78	October 8	.45	103
April 19	.23	64	October 27	.57	117
May 4	.38	90	November 3	.56	114
June 4	2.50	764	November 10	.52	108
June 13	1.72	427	November 17	.53	108
June 18	1.32	290	November 24	.79	160
June 25	1.15	251	November 30	.48	97
July 9	.38	84	December 7	*a* .50	74
July 25	−.10	32			

a Gage height doubtful on account of ice.

Daily gage height, in feet, of Uinta River at Ouray School, Utah, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(*a*)	0.28	0.50	3.30	0.70	−0.23	−0.05	0.58	0.49	0.30
2	(*a*)	.25	.48	3.20	.70	−.28	.00	.70	.57	.43
3	(*a*)	.30	.42	2.70	.....	−.35	−.04	.56	.53	.30
4	(*a*)	.45	.38	2.50	.66	−.31	.09	.56	.56	(*a*)
5	(*a*)	.39	.39	2.40	.68	−.22	.25	.52	.54	(*a*)
6	(*a*)	.46	.47	2.25	.....	.07	.23	.51	.54	(*a*)
7	(*a*)	.48	.49	2.10	.42	.03	.18	.51	.52	(*a*)
8	(*a*)	.47	.47	2.00	.39	−.01	.11	.49	.52	(*a*)
9	0.80	.42	.56	1.90	.37	−.14	.....	.50	.50	(*a*)
10	.....	.42	.90	1.90	.....	−.20	.60	.54	.50	.54
11	.64	.35	1.35	1.82	.20	−.21	.72	.51	.49	*b* .46
12	.66	.34	1.89	1.98	.12	−.22	.45	.51	.45	.....
13	.58	.37	1.84	1.70	−.04	−.20	.36	.56	.48	.....
14	.58	.34	1.72	1.60	−.04	−.20	.27	.54	.51	.....
15	.52	.30	1.68	1.50	−.05	−.20	.26	.52	.45	.....
16	.50	.28	2.27	.....	−.04	−.19	.26	.52	.51	.....
17	.48	.27	2.77	.....	.05	−.18	.26	.52	.52	.....
18	.46	.25	2.95	.....	−.02	−.17	.21	.52	.68	.....
19	.40	.24	2.95	1.24	−.04	−.14	.22	.57	.68	.....
20	.38	.25	2.95	1.25	−.06	−.08	.26	.60	.68	.....
21	.35	.29	2.90	1.30	−.06	−.05	.29	.60	.62	.....
22	.30	.35	2.85	1.15	−.10	−.02	.27	.57	.71	.....
23	.30	.46	3.48	1.15	−.10	−.05	.26	.58	.90	.....
24	.30	.31	3.73	1.30	−.10	−.01	.47	.60	.71	.....
25	.31	.31	3.70	1.15	−.06	.07	1.10	.57	.70	.....
26	.30	.25	3.70	1.02	.07	.10	.70	.56	.78	.....
27	.30	.25	4.00	.....	.01	.07	.70	.56	.68	.....
28	.28	.25	4.15	.85	−.12	−.01	.65	.60	.61	.....
29	.20	1.05	3.80	.82	−.16	−.02	.60	.52	.38	.....
30	.23	.80	3.55	.....	−.19	−.04	.58	.54	.25	.....
31	.29	.....	3.05	.....	−.20	−.07	.....	.49	.....	.....

a Frozen. *b* Readings discontinued for winter December 11.

LAKE CREEK, UTAH, NEAR MOUTH.

This stream has its source on the southern slope of the Uinta Mountains, and drains an area immediately to the west of the basin of Uinta River. It empties into Duchesne River about 3 miles above the bridge over the latter stream on the stage road from Fort Duchesne to Price. The permanent gage rod consists of a 1-inch by 4-inch by 8-foot board nailed vertically to the west abutment on the lower side of the wagon bridge near the mouth of the creek. Bench mark No.

1 is a 20-penny wire nail in the abutment opposite the 4.50-foot mark on the gage. Bench mark No. 2 is directly over the gage rod, and is the head of a wire nail in the southwest corner of the bridge upright. Its elevation is 5,066.58 feet above sea level; the elevation of the zero of the rod is 5,055.99 feet above sea level. The channel of the river has a sharp bend about 100 feet above the bridge, but is straight for about 600 feet below it. The bed is composed of medium-sized cobblestones, and forms a fair section. During flood stages measurements are made from the bridge, but at other periods they are made by wading at a point about 400 feet below it.

Lake Creek is formed by the junction of an east and a west fork about 25 miles above its mouth. During 1900 the following measurements were made of these forks and of the main stream a short distance below the junction:

Miscellaneous discharge measurements of Lake Creek and its tributaries.

Date.	Stream.	Locality.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-ft.*
August 6	West Fork	Above mouth	1.40	93
Do	East Fork	do	2.10	112
Do	Lake Creek	One-half mile below junction of forks	2.67	290
August 14	West Fork	Above mouth	1.22	69
Do	East Fork	do	1.94	87
Do	Lake Creek	One-half mile below junction of forks	2.49	192

During 1900 the following measurements of the discharge at the main station, near the mouth of the creek, were made by C. T. Prall and others:

Discharge measurements of Lake Creek, Utah, near mouth.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
July 3	2.40	256	October 4	2.05	132
July 18	2.08	134	October 31	1.95	102
August 3	1.96	109	November 8	1.95	105
August 16	1.86	96	November 15	1.93	102
August 23	1.88	99	November 23	a2.10	138
August 31	1.80	85	December 6	a2.32	148
September 7	1.90	101	December 13	a2.38	121
September 14	1.98	123	December 20	a2.10	108

a Gage height doubtful on account of ice.

DUCHESNE RIVER AT PRICE ROAD BRIDGE, UTAH.

This station, established by C. C. Babb on October 26, 1899, is 3 miles below the mouth of Lake Creek, at the highway bridge on the stage road from Price to Fort Duchesne. It is described in Water-Supply Paper No. 37, page 291. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, pages 322, 323, and 325.

Twice during the year 1900 C. T. Prall measured the main river at the ford immediately above the mouth of Strawberry Creek, or about 23 miles above the main station, with the following results:

September 15: Gage height, 2.10 feet; discharge, 216 second-feet.
October 5: Gage height, 2.14 feet; discharge, 232 second-feet.

Mr. Prall also made two measurements of the flow of Strawberry Creek a short distance from its mouth and one-fourth of a mile below the mouth of Indian Creek, with the following results:

September 15: Discharge, 84 second-feet.
October 5: Gage height, 1.20 feet; discharge, 92 second-feet.

During 1900 the following measurements at the main gaging station were made by and Mr. Prall and others:

Discharge measurements of Duchesne River at Price road bridge, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
March 10	5.25	283	August 3	5.10	286
March 17	5.28	311	August 18	4.98	247
March 23	5.50	393	August 23	5.05	284
March 31	5.43	328	September 1	4.98	246
April 14	5.52	414	September 7	5.07	279
April 20	5.48	391	September 13	5.18	338
May 5	5.89	583	September 20	5.08	275
May 19	7.55	2,674	October 4	5.25	325
May 25	8.20	3,807	October 31	5.20	294
June 5	7.58	2,667	November 8	5.18	294
June 14	6.70	1,466	November 15	5.18	291
June 21	6.20	995	November 23	5.30	357
June 27	5.98	677	December 6	5.38	356
July 11	5.43	441	December 13	5.22	316
July 19	5.28	386			

Daily gage height, in feet, of Duchesne River at Price road bridge, Utah, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.48	6.00	8.58	5.75	5.11	4.95	5.31	5.20	5.20
2	.....	5.32	5.90	8.35	5.65	5.12	4.98	5.31	5.20	5.27
3	.....	5.37	5.88	8.20	5.62	5.11	4.97	5.29	5.20	5.33
4	5.41	5.63	5.83	8.10	5.60	5.12	5.07	5.28	5.20	5.39
5	5.42	5.61	5.85	7.65	5.60	5.22	5.15	5.25	5.20	5.44
6	5.46	5.58	5.95	7.38	5.50	5.35	5.15	5.22	5.20	5.45
7	5.39	5.51	6.08	7.45	5.42	5.32	5.08	5.20	5.20	5.40
8	5.40	5.55	6.10	7.45	5.40	5.20	5.02	5.20	5.20	5.40
9	5.30	5.55	6.20	7.24	5.40	5.19	5.10	5.19	5.20	5.33
10	5.27	5.60	6.45	7.16	5.39	5.18	5.23	5.20	5.20	5.30
11	5.35	5.50	6.70	7.00	5.44	5.11	5.28	5.20	5.20	5.30
12	5.34	5.51	7.04	6.93	5.40	5.10	5.20	5.24	5.19	5.25
13	5.29	5.52	6.93	6.83	5.39	.....	5.18	5.24	5.17	5.23
14	5.30	5.51	6.70	6.73	5.40	.....	5.12	5.21	5.18	5.23
15	5.31	5.48	6.71	6.60	5.35	.....	5.09	5.20	5.18	5.23
16	5.29	5.49	7.00	6.50	5.40	5.00	5.07	5.21	5.19	(a)
17	5.29	5.46	7.28	6.45	5.40	4.99	5.02	5.22	5.19	.....
18	5.29	5.45	7.45	6.39	5.36	4.98	5.01	5.22	5.23	.....
19	5.27	5.43	7.55	6.35	5.31	4.98	5.01	5.22	5.22	.....
20	5.27	5.45	7.48	6.26	5.28	5.00	5.07	5.29	5.27	.....
21	5.29	5.51	7.40	6.23	5.29	5.08	5.09	5.28	5.25	.....
22	5.30	5.59	7.48	6.16	5.29	5.11	5.09	5.27	5.31	.....
23	5.45	5.62	7.80	6.13	5.30	5.05	5.14	5.28	5.30	.....
24	5.70	5.61	8.05	6.10	5.35	5.00	5.39	5.28	5.30	.....
25	5.95	5.61	8.20	6.10	5.37	5.02	5.38	5.28	5.20	.....
26	5.69	5.58	8.45	6.03	5.38	.....	5.29	5.28	5.24	.....
27	5.73	5.61	9.05	5.99	5.39	.....	5.54	5.24	5.20	.....
28	5.69	5.70	9.35	5.94	5.37	5.00	5.39	5.23	5.20	.....
29	5.53	6.15	9.00	5.90	5.24	.....	5.30	5.22	5.20	.....
30	5.43	6.05	8.70	5.82	5.17	4.92	5.28	5.23	5.20	.....
31	5.43	.....	8.50	.....	5.12	4.92	.....	5.21	.....	.....

a Frozen.

GREEN RIVER DRAINAGE IN COLORADO.

No stations are maintained in Colorado upon Green River or any of its tributaries, but in November, 1900, a short trip was made into the basin, and a number of gagings were made, the results of which are given in the following table:

Miscellaneous discharge measurements in northwestern Colorado.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
November 5	Yampa River	Craig	A. L. Fellows	282
November 6	Williams River	Hamilton	do	35
Do	Axial River	Axial	do	5
November 2	Yampa River	Thornburg Bridge	do	322
November 1	do	Lily Park	do	371
Do	Snake River	do	do	65
November 7	White River	Meeker	do	394
Do	Piciance Creek	White River City	do	13
November 8	White River	Rangely	do	413

GRAND RIVER, COLORADO.

This stream is the largest in Colorado, and drains a greater portion of the State than any other river. It rises in the north-central part of the State, in Middle Park, and drains the mountainous country on the west side of the Front Range and on the south side of the Continental Divide, the river and its tributaries flowing through mountainous tracts at their heads, and thence through canyons and broken country throughout the rest of their courses. Upon most of the streams little irrigation has been practiced, except along the valleys immediately contiguous to the channels. The Uncompahgre, however, is an exception, practically all of the water of that stream having been diverted and used in irrigating the tablelands of the Uncompahgre Valley. Dolores River also furnishes a notable exception, its waters being carried through the divide between the Grand and San Juan drainage basins and used to irrigate lands lying in the latter drainage. Owing to the comparatively small amount of land that has been irrigated along Grand River, only a small fraction of the water in this division has been used; but a number of projects have been devised for the construction of large canals to carry the water to the fertile benches lying along the various streams, and in the case of Gunnison River there is a project to carry its waters through the divide for the purpose of irrigating lands in Uncompahgre Valley.

GRAND RIVER AT GLENWOOD SPRINGS, COLORADO.

This station was first located May 12, 1899, at the request of the Denver and Rio Grande Railroad Company, at the railroad bridge a quarter of a mile west of the depot and just above the mouth of Roaring Fork. A wire gage was used. At the beginning of 1900, however, a new gage rod was located near the electric-light works of the Colorado Hotel. Measurements are made from the wagon bridge crossing the river between the town and the hotel. The channel is

good, being composed of gravel and rock, and does not change much; the banks are high and not subject to overflow. Gage readings were taken during only the high-water season of 1899, being discontinued June 17. They were resumed, however, on January 1, 1900, at the new station.

During 1900 Roaring Fork was measured twice at Glenwood Springs—the first time on July 8, when the discharge was 1,570 second-feet, and the second time on August 23, when the discharge was 423 second-feet.

A description of the Glenwood Springs station was published in Water-Supply Paper No. 37, page 293. During 1900 the following measurements of Grand River were made by A. L. Fellows:

March 19: Gage height, 3.80 feet; discharge, 1,140 second-feet.
July 8: Gage height, 5.40 feet; discharge, 3,764 second-feet.
August 23: Gage height, 3.60 feet; discharge, 1,086 second-feet.

Daily gage height, in feet, of Grand River at Glenwood Springs, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	3.50	3.45	3.75	5.20	10.05	6.45	4.10	3.40	3.20	3.20	3.05
2	3.45	3.45	3.45	3.95	5.25	9.75	6.30	4.05	3.40	3.20	3.20	3.25
3	3.45	3.45	3.50	4.15	5.20	9.65	6.25	4.00	3.35	3.20	3.20	3.00
4	3.45	3.45	3.55	4.25	5.40	9.55	6.00	3.90	3.30	3.20	3.20	3.15
5	3.55	3.45	3.65	4.30	6.05	9.10	5.85	3.95	3.30	3.20	3.20	3.25
6	3.55	3.40	3.60	4.30	6.20	8.80	5.75	4.10	3.30	3.20	3.20	3.25
7	3.45	3.40	3.50	4.25	6.30	9.00	5.55	4.10	3.30	3.20	3.20	3.35
8	3.40	3.30	3.50	4.45	6.55	9.30	5.45	4.00	3.30	3.20	3.20	3.30
9	3.40	3.35	3.55	4.50	6.85	9.40	5.40	3.95	3.30	3.20	3.20	3.15
10	3.45	3.40	3.65	4.40	7.30	9.35	5.30	3.90	3.35	3.20	a3.20	3.10
11	3.35	3.40	3.70	4.20	7.80	9.10	5.25	3.80	3.40	3.20	3.20	3.00
12	3.35	3.50	3.90	4.10	8.10	8.60	5.10	3.80	3.40	3.20	3.30	2.90
13	3.45	3.35	4.00	3.95	8.10	8.25	5.00	3.80	3.40	3.20	3.30	2.85
14	3.50	3.40	4.10	4.00	7.90	8.20	5.00	3.70	3.40	3.20	3.25	2.80
15	3.55	3.40	4.10	4.10	7.65	8.05	4.90	3.70	3.40	3.20	3.40	3.00
16	3.50	3.50	4.00	4.20	7.45	8.05	4.85	3.60	3.30	3.20	3.40	3.00
17	3.50	3.35	3.95	4.10	7.60	8.15	4.70	3.60	3.20	3.20	3.40	3.00
18	3.45	3.40	3.85	4.05	7.80	8.10	4.70	3.60	3.20	3.20	3.40	3.05
19	3.45	3.40	3.85	3.95	7.90	7.95	4.50	3.60	3.20	3.20	3.40	3.00
20	3.45	3.45	3.85	3.85	7.80	7.90	4.50	3.60	3.20	3.20	3.50	3.00
21	3.30	3.45	3.90	4.25	7.75	7.90	4.40	3.60	3.20	3.20	3.35	3.10
22	3.40	3.35	3.90	4.70	7.50	7.95	4.40	3.60	3.20	3.20	3.40	3.10
23	3.35	3.45	3.95	4.90	7.80	7.90	4.40	3.60	3.20	3.20	3.40	3.10
24	3.45	3.35	3.95	4.70	8.25	7.95	4.40	3.60	3.20	3.20	3.45	3.00
25	3.35	3.45	4.05	4.70	8.55	7.80	4.40	3.60	3.20	3.20	3.35	3.00
26	3.30	3.45	4.00	4.65	8.70	7.60	4.40	3.60	3.20	3.20	3.20	3.10
27	3.35	3.50	4.05	4.65	9.10	7.25	4.40	3.60	3.20	3.20	3.25	3.15
28	3.40	3.40	4.05	4.75	9.65	6.95	4.30	3.60	3.20	3.20	3.30	3.00
29	3.40	.....	3.90	5.10	10.00	6.80	4.30	3.60	3.20	3.20	3.20	2.80
30	3.40	.....	3.85	5.30	10.15	6.55	4.30	3.50	3.20	3.20	3.15	2.95
31	3.50	.....	3.80	.....	10.15	.....	4.15	3.50	.....	3.20	.....	2.90

a Estimated from September 24 to November 10.

GRAND RIVER AT GRAND JUNCTION, COLORADO.

This station, established October 18, 1894, is at the wagon bridge across the river near the pump house of the city waterworks at Grand Junction and a short distance above the mouth of Gunnison River. The river at this point discharges through two channels, and a record is kept of the discharge in each channel, requiring separate discharge measurements. During the last four years the greater part of the water has run through the left channel, and during the year 1900 there was a flow through the right channel for a short time only. Gage

rod No. 1 is attached to the south end of the wagon bridge crossing the river south of the town. Gage rod No. 2 consists of a wire and weight fastened to the upper side of the bridge over the left channel. The channel is sandy and shifting, and the discharge must, therefore, be considered approximate. During 1900 no measurements were made in the right channel and only two measurements were made in the left channel. Owing to the few measurements made and to the shifting of the channel no rating table was possible. W. H. Smith, of Grand Junction, made the reports throughout the year. A description of the station was published in Water-Supply Paper No. 37, page 294. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 281. During 1900 the following measurements were made by A. L. Fellows at rod No. 2:

March 20: Gage height, 4.15 feet; discharge, 1,762 second-feet.
July 7: Gage height, 5.80 feet; discharge, 6,177 second-feet.

Daily gage height, in feet, of Grand River at Grand Junction, Colorado, for 1900.

[Rod No. 1—right channel.]

Day.	May.	June.	Day.	May.	June.	Day.	May.	June.	Day.	May.	June.
1		4.70	9		3.45	17			25		
2		4.50	10		3.50	18			26		
3		4.05	11		3.30	19			27	3.80	
4		3.75	12		2.40	20			28	4.30	
5		3.50	13		2.00	21			29	4.55	
6		3.40	14		(a)	22			30	4.40	
7		3.20	15			23			31	4.70	
8		3.15	16			24					

a This channel was dry after June 13.

Daily gage height, in feet, of Grand River at Grand Junction, Colorado, for 1900.

[Rod No. 2—left channel.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				4.30	5.60	10.35	6.70	3.35	2.40	3.10	2.80	2.45
2				4.30	5.60	10.20	6.60	3.30	2.40	3.05	2.80	
3		3.90	3.90	4.40	5.50	a10.00	6.45	3.30	2.40	3.00	2.80	
4				4.40	5.55	a9.80	6.25	3.15	2.50	3.00	2.80	
5				4.50	5.85	9.60	5.95	3.10	2.50	3.00	2.80	2.50
6				4.50	6.50	9.10	5.65	3.10	2.50	3.10	2.75	
7	(b)			4.60	6.90	9.05	5.40	3.05	2.50	3.10	2.70	
8				4.60	6.95	9.10	5.20	3.10	2.50	3.10	2.70	
9				4.70	7.50	9.45	5.20	3.00	2.50	3.00	2.70	
10		3.60	4.00	4.60	8.25	9.05	5.20	3.00	2.60	3.00	2.70	
11				4.50	8.60	9.10	5.20	3.00	2.60	3.00	2.60	
12				4.40	a8.60	8.80	5.10	2.90	2.70	2.90	2.65	2.70
13	(b)			4.25	a8.65	8.60	4.75	2.90	2.80	2.90	2.60	
14				4.10	a8.65	8.75	4.70	2.90	2.90	2.90	2.65	
15				4.20	a8.70	8.75	4.60	2.90	2.90	2.90	2.60	
16				4.20	8.70	8.65	4.50	2.90	2.85	2.90	2.60	
17		3.80	4.30	4.20	9.10	8.35	4.50	2.75	2.75	2.90	2.60	
18				4.10	9.20	8.70	4.40	2.55	2.60	2.90	2.60	
19				4.05	9.20	8.40	4.00	2.50	2.60	2.90	2.65	2.50
20	3.70			4.00	9.20	8.45	4.00	2.50	2.60	2.90	2.85	
21				4.10	8.90	8.30	3.95	2.50	2.60	2.90	2.90	
22				4.45	8.60	8.25	4.00	2.50	2.60	3.10	2.90	
23				5.05	8.85	8.45	3.90	2.50	2.75	3.05	2.90	
24		3.90	4.30	5.30	9.30	8.30	3.90	2.50	2.95	3.00	2.90	
25				5.00	9.55	8.35	3.80	2.50	3.05	3.00	2.90	
26	3.60			4.80	9.75	8.15	3.80	2.40	3.25	2.90	2.90	2.60
27				4.80	9.95	7.55	3.80	2.40	3.30	2.90	2.80	
28				5.05	10.55	7.50	3.75	2.40	3.15	2.95	2.75	
29				5.25	10.80	7.25	3.70	2.40	3.10	3.00	2.65	
30				5.40	10.95	6.90	3.70	2.40	3.10	2.90	2.55	
31					11.15		3.45	2.40		2.90		

a Estimated. b Frozen.

GUNNISON RIVER AT IOLA, COLORADO.

Gunnison River, the largest tributary of the Grand in Colorado, rises in the south-central part of the State, in the Saguache Mountains and the Cochetopa Hills, and flows in a westerly direction, emptying into Grand River near the western boundary of the State, a short distance south of Grand Junction. Comparatively little of the water is used for irrigation, but a canal line has been surveyed with a view to taking the water from the river and carrying it to the valley of the Uncompahgre. It was for the purpose of determining the amount of water available for this project that the Iola station was established in March, 1900. The rod is at a wagon bridge which crosses the river about a quarter of a mile above the Denver and Rio Grande Railroad station at Iola. It consists of a piece of 2-inch by 4-inch timber fastened to the downstream side of the second pier of the bridge from the south end, the zero of the rod being 7.43 feet below the bench mark—a spike in the base of an old post 40 feet south of the southern end of the bridge, on the west side of the road. The chief value of the station is with reference to determining the amount of water available for the proposed canal to the Uncompahgre Valley, although, owing to the fact that a number of streams enter the Gunnison below the station, the results obtained do not show the total amount available. The channel at this place is wide, and the bed being of gravel and bowlders is not particularly susceptible to change. The banks, although not high, are not subject to overflow. The observer is A. Pomel, postmaster at Iola, who telegraphs the gage height daily to the local forecast official of the United States Weather Bureau at Denver, who has it printed in the morning papers.

The station on Gunnison River previously maintained at Grand Junction was not continued during the year 1900, for the reason that during high stages of Grand River the water backs up Gunnison River considerably above the point where the gage rod is located, seriously affecting the gage readings. Two measurements were made there, however, the first on March 20, when, with a gage height of 2.50 feet, the discharge was 1,477 second-feet, and the second on July 7, when, with a gage height of 2.90 feet, the discharge was 2,121 second-feet.

During 1900 the following measurements were made at the Iola station by A. L. Fellows:

May 3: Gage height, 3 feet; discharge, 1,272 second-feet.
June 28: Gage height, 3.40 feet; discharge, 1,658 second-feet.
July 5: Gage height, 2.90 feet; discharge, 1,169 second-feet.
August 9: Gage height, 2.20 feet; discharge, 431 second-feet.
August 25: Gage height, 2.10 feet; discharge, 392 second-feet.

Daily gage height, in feet, of Gunnison River at Iola, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	2.4	2.9	5.7	3.1	2.1	2.1	2.0
2	2.5	3.0	5.3	3.1	2.1	2.1	2.0
3	2.4	3.0	5.4	3.0	2.1	2.1	2.0
4	2.5	3.2	5.2	2.9	2.1	2.0	2.0
5	2.5	3.4	5.1	2.9	2.1	2.0	2.0
6	2.4	3.5	5.1	2.8	2.1	2.0	2.0
7	2.4	3.6	5.2	2.8	2.1	2.0	2.0
8	2.5	3.9	5.2	2.7	2.1	2.0	2.0
9	2.4	4.0	5.0	2.7	2.2	2.0	2.0
10	2.4	4.6	4.8	2.6	2.2	2.0	2.0
11	2.3	4.6	4.6	2.6	2.2	2.0	2.0
12	2.3	4.8	4.6	2.6	2.1	2.0	2.0
13	2.3	4.7	4.5	2.6	2.1	2.0	2.0
14	2.3	4.6	4.4	2.5	2.1	2.0	2.0
15	2.4	4.4	4.0	2.5	2.1	2.0	2.0
16	2.4	4.6	4.0	2.5	2.1	2.0	2.0
17	2.4	4.8	4.2	2.4	2.1	2.0	2.0
18	2.4	4.9	4.1	2.4	2.1	2.0	2.0
19	2.4	4.8	4.0	2.3	2.1	2.0	2.0
20	2.5	4.8	3.9	2.3	2.1	2.0	2.0
21	2.7	4.6	3.9	2.2	2.1	2.0	2.0
22	3.0	4.6	4.0	2.1	2.1	2.0	2.0
23	2.8	4.7	4.0	2.1	2.1	2.0	2.0
24	2.7	5.0	4.0	2.1	2.1	2.0	2.0
25	2.7	5.0	3.9	2.1	2.1	2.0	2.0
26	2.6	5.1	3.7	2.1	2.1	2.0	2.0
27	2.6	5.4	3.5	2.1	2.1	2.0	2.0
28	2.8	5.6	3.4	2.2	2.1	2.0	2.0
29	2.9	5.7	3.3	2.2	2.1	2.0	2.0
30	3.0	5.8	3.2	2.1	2.1	2.0	2.0
31	.....	5.8	.....	2.1	2.1	.....	2.0

UNCOMPAHGRE RIVER AT MONTROSE, COLORADO.

Uncompahgre River has its source in Ouray County, in the high peaks of southwestern Colorado, and flows northwesterly, entering Gunnison River at Delta. The upper portion of its drainage basin is mountainous, but proceeding downstream the country becomes more rolling, and irrigation is possible along the valleys and adjacent mesas. In the vicinity of Montrose a number of canals divert nearly all of the normal flow of the Uncompahgre, and if further irrigation is to be had in the district recourse must be had to storage or to a diversion of the waters of Gunnison River.

The Fort Crawford station on the Uncompahgre, previously maintained, was not kept up during the year 1900, owing to the extremely shifting character of the channel at that place, and instead the station at Montrose was established in the fall of 1899, no records being kept, however, until the spring of 1900. During the greater portion of the year there is little water at Montrose, the canals above diverting most of the flow. The station is at the bridge which crosses the river opposite the town, about a half mile from the depot of the Denver and Rio Grande Railroad. The rod consists of a 1-inch by 4-inch board nailed to the inside of the pier just above the bridge. The channel being of gravel and bowlders is favorable to obtaining accurate measurements, not being susceptible to change. The banks are high and are not subject to overflow. Records were kept for a short time only, as there was little water during the greater part of the irrigation season of 1900. The observer was Mr. W. E. Obert, com-

missioner of the Montrose water district. The records were discontinued July 7, 1900. During the year the following measurements were made by A. L. Fellows:

July 5: Gage height, 1.80 feet; discharge, 150 second-feet.
August 10: Gage height, 0.50 foot; discharge, 2 second-feet.

Daily gage height, in feet, of Uncompahgre River at Montrose, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Day.	Apr.	May.	June.	July.	Day.	Apr.	May.	June.	July.
1	.....	1.20	2.75	1.70	12	.68	1.60	2.75	.....	23	1.06	2.20	2.90	.....
2	.....	1.20	2.70	1.70	13	.90	1.35	2.60	.....	24	1.10	2.65	2.65	.....
3	.....	1.18	2.65	1.60	14	.93	1.40	2.60	.....	25	1.00	2.30	2.55	.....
4	.....	1.32	2.75	1.85	15	.92	1.65	2.40	.....	26	.98	2.50	2.40	.....
5	.....	1.45	2.65	1.75	16	.98	2.25	2.50	.....	27	.95	2.55	2.05	.....
6	.....	1.00	2.65	1.65	17	1.02	2.35	2.35	.....	28	1.00	2.75	1.70	.....
7	.....	1.00	2.70	1.15	18	.98	2.20	2.30	.....	29	1.10	2.90	1.65	.....
8	1.05	1.12	2.45	.....	19	1.05	2.10	2.10	.....	30	1.15	2.85	1.60	.....
9	.90	1.40	2.35	.....	20	1.18	2.00	1.90	.....	31	.....	2.80	.....	.....
10	.78	1.65	2.70	.....	21	1.18	1.90	1.75	.....					
11	.75	1.65	2.75	.....	22	1.18	1.85	1.60	.....					

DOLORES RIVER AT DOLORES, COLORADO.

This river is the last important tributary of Grand River. It rises in the La Plata and San Miguel mountains, the highest peak of which, Mount Wilson, attains an elevation of more than 14,000 feet. For about 50 miles its course is southwesterly; it then turns and flows in an almost due north direction for nearly 100 miles; then turns to the west and enters Grand River after passing into Utah. Throughout the greater part of its course the river flows through natural canyons, and comparatively little irrigation is practiced along the stream itself, except at Dolores, where for about 40 miles the valley widens to from a half mile to a mile, and a number of ranches are cultivated. By far the greater part of the waters of the river, however, is used in the San Juan watershed, being diverted by means of a tunnel and a great cut in Montezuma Valley. The head gates of the canals carrying this water are about 2 miles west of the town of Dolores. The gaging station is above the head gates, and about a half mile above the Colorado Southern Railroad station at Dolores. The gage rod consists of a vertical plank attached to the left abutment of the footbridge crossing the river. The channel is not subject to change, and the results obtained are excellent. The bed of the stream is composed of small stones and gravel, and the banks are high and do not overflow. The observer is Mrs. M. D. Smith, of Dolores. A description of the station was published in Water-Supply Paper No. 38, page 305. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 282. During 1900 the following measurements were made by A. L. Fellows:

March 24: Gage height, 2.90 feet; discharge, 145 second-feet.
May 5: Gage height, 3.90 feet; discharge, 767 second-feet.
June 27: Gage height, 3.25 feet; discharge, 320 second-feet.
August 11: Gage height, 2.60 feet; discharge, 31 second-feet

Daily gage height, in feet, of Dolores River at Dolores, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	3.00	2.80	2.95	3.50	4.90	3.10	2.60	2.50	2.80	2.80	*a* 3.05
2	3.10	2.90	2.80	3.15	3.55	4.75	3.10	2.60	2.50	2.80	2.80	3.10
3	3.10	2.90	2.75	3.00	3.50	4.70	3.05	2.60	2.60	2.70	2.80	3.10
4	3.10	2.90	2.70	2.95	3.60	4.50	3.00	2.60	2.60	2.70	2.80	3.20
5	3.10	2.90	2.70	3.10	4.05	4.35	3.00	2.60	2.65	2.80	2.80	3.20
6	3.10	2.90	2.70	3.15	3.95	4.35	2.90	2.60	2.70	2.90	2.80	3.35
7	3.10	2.90	2.60	3.05	4.15	4.35	2.90	2.60	2.85	2.85	2.70	3.35
8	3.10	2.90	2.60	3.00	4.15	4.25	2.80	2.60	3.10	2.80	2.70	3.25
9	3.10	2.90	2.75	2.95	4.40	4.20	2.80	2.60	3.00	2.80	2.60	3.05
10	3.10	2.90	2.75	2.90	4.45	4.15	2.80	2.60	2.90	2.80	2.60	3.10
11	3.10	2.90	2.75	2.90	4.75	4.10	2.80	2.60	2.90	2.80	2.60	3.15
12	3.10	2.90	2.75	2.90	4.90	4.00	2.80	2.60	2.90	2.80	2.60	3.15
13	3.10	2.90	2.85	2.85	4.65	3.95	2.80	2.50	2.90	2.80	2.60	3.15
14	3.10	2.90	2.85	2.85	4.55	3.95	2.80	2.50	2.90	2.80	2.60	3.15
15	3.10	2.90	2.85	3.00	4.65	3.90	2.80	2.50	2.80	2.80	2.70	3.40
16	3.10	2.90	2.95	3.10	4.85	3.90	2.70	2.50	2.80	2.80	2.75	3.15
17	3.10	2.90	2.95	3.10	5.00	3.85	2.70	2.50	2.70	2.80	2.80	3.05
18	3.10	2.90	3.05	3.20	5.05	3.85	2.70	2.50	2.70	2.80	2.90	3.05
19	3.10	2.80	2.95	3.25	5.05	3.85	2.70	2.60	2.70	2.80	3.00	2.95
20	3.10	2.80	2.95	3.40	4.80	3.80	2.70	2.60	2.60	2.90	3.10	2.95
21	3.00	2.80	2.95	3.55	4.45	3.75	2.70	2.55	2.60	2.80	3.10	2.90
22	3.00	2.80	2.95	3.60	4.70	3.65	2.70	2.50	2.60	2.80	2.95	2.85
23	3.00	2.80	2.90	3.60	4.95	3.50	2.70	2.50	2.65	2.80	2.85	3.00
24	3.00	2.80	2.90	3.45	4.95	3.50	2.60	2.50	2.95	2.80	2.80	*a* 3.00
25	3.00	2.80	2.90	3.40	5.00	3.50	2.60	2.50	3.15	2.80	2.70	*a* 3.00
26	3.00	2.80	2.90	3.40	4.90	3.40	2.60	2.40	2.95	2.80	2.70	*a* 3.00
27	3.00	2.80	2.90	3.45	4.95	3.30	2.60	2.40	2.85	2.80	2.80	*a* 3.00
28	3.00	2.80	2.85	3.50	5.00	3.25	2.60	2.40	2.80	2.80	2.80	*a* 3.00
29	3.00	.....	2.80	3.45	5.05	3.20	2.60	2.40	2.80	2.80	2.90	*a* 3.00
30	3.00	.....	2.90	3.40	4.95	3.20	2.60	2.40	2.80	2.80	3.00	*a* 3.00
31	3.00	.....	2.95	.....	5.00	.....	2.60	2.45	.....	2.80	.....	*a* 3.00

a Estimated.

SAN JUAN RIVER.

San Juan River rises in the San Juan Mountains, the small streams at the head flowing westerly, the opposite of the direction taken by the branches of the Conejos. The country is generally mountainous and rough, and but little irrigation is practiced along the river, except in the bottom lands adjacent to the channel. The stream flows a short distance through Colorado and then enters New Mexico, through which Territory it flows for about 100 miles, then crosses the southwest corner of Colorado again, and flows through Utah to its junction with the Colorado at Henry Mountain. The principal tributaries flowing from Colorado into this river are the Piedra, Los Pinos, Florida, Animas, La Plata, and Mancos rivers, all of which flow through comparatively natural valleys, crossing the line into New Mexico before they unite with the San Juan. A large portion of this country remained a part of the Southern Ute Indian Reservation until 1899, when the western half of that reservation was thrown open to settlement, and a number of tracts have been taken. A very considerable portion of the most desirable lands, however, were taken by the Indians in severalty. There are a number of excellent mesas of good farming land which will without doubt eventually be irrigated; a number of surveys have already been made of canal lines to cover these tracts, which will be pushed to a speedy conclusion.

The only stations maintained in this basin in 1900 are at Ignacio

on Los Pinos River, at Durango on Animas River, and at Mancos on Mancos River, the stations at Arboles on the San Juan and the Rio Grande and at Durango on Florida River being abandoned, their objects having been accomplished.

LOS PINOS RIVER AT IGNACIO, COLORADO.

This stream derives its supply from the western end of the San Juan Mountains and from the southern slope of the Needle Mountains in Colorado. It flows in a southerly direction for about 50 miles, crossing the Colorado line about 5 miles south of La Boca, on the Denver and Rio Grande Railroad. The valley is generally wider than the valleys of the Piedra and the San Juan, and more irrigation is practiced along the borders of the stream. Several Government canals have been constructed for the benefit of the Indians located on the bottom lands. A number of irrigation canals have been projected and surveys made for the purpose of taking out water upon the adjacent benches. The station was established April 22, 1899, at the request of the Commissioner of Indian Affairs, for the purpose of ascertaining the quantity of water available for irrigation along the stream. Unfortunately, records have not been sent in regularly. The gage rod is fastened to the middle pier of the bridge crossing the river at Ignacio, the subagency of the Southern Ute Indian Reservation, 2 miles south of the station of the Denver and Rio Grande Railroad. The channel is fairly stable, being of gravel and bowlders, and has suffered little change since the station was established. The rod is a vertical 2-inch by 4-inch timber 10 feet long, spiked to the bridge, the marks being strips of brass securely nailed to the post. The 8-foot mark on the gage rod is level with the top of the lower end of a 6-inch by 8-inch timber protruding from the downstream side of the pier on the right-hand side. The banks, although not high, are not subject to overflow. The station is an important one, as all of the waters of the stream will undoubtedly be used for irrigation before many years. Already large reservoirs are contemplated near the head of the river, where there are a number of beautiful lakes. The observer is the clerk at the agency. A description of the station was published in Water-Supply Paper No. 38, page 309. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 299. During 1900 the following measurements were made by A. L. Fellows:

March 26: Gage height, 2.60 feet; discharge, 137 second-feet.
May 8: Gage height, 3.50 feet; discharge, 604 second-feet.
August 14: Gage height, 2 feet; discharge, 25 second-feet.

Daily gage height, in feet, of Los Pinos River at Ignacio, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	2.50	2.30	2.30	2.50	.....	17	2.40	2.30	2.50	.....	4.50
2	2.50	2.30	2.30	2.55	.....	18	2.40	2.30	2.50	.....	4.55
3	2.50	2.30	2.30	2.65	.....	19	2.40	2.30	2.50	.....	4.50
4	2.50	2.30	2.30	2.70	.....	20	2.40	2.30	2.50	.....	4.25
5	2.50	2.30	2.30	2.70	.....	21	2.40	2.30	2.55	.....	4.05
6	2.45	2.30	2.30	2.70	.....	22	2.40	2.30	2.60	.....	3.90
7	2.40	3.30	2.30	2.70	.....	23	2.40	2.30	2.60	.....	4.00
8	2.50	2.30	2.30	(a)	.....	24	2.40	2.30	2.60	.....	4.70
9	2.50	2.30	2.30	.....	3.85	25	2.30	2.30	2.60	.....	4.60
10	2.50	2.30	2.30	.....	4.05	26	2.30	2.30	2.60	.....	4.90
11	2.50	2.30	2.30	.....	4.05	27	2.30	2.30	2.60	.....	.....
12	2.50	2.30	2.35	.....	4.15	28	2.30	2.30	2.55	.....	.....
13	2.45	2.30	2.40	.....	4.20	29	2.30	.....	2.50	.....	.....
14	2.40	2.30	2.50	.....	4.00	30	2.30	.....	2.50	.....	.....
15	2.40	2.30	2.50	.....	4.15	31	2.30	.....	2.50	.....	.....
16	2.40	2.30	2.50	.....	4.35						

a No readings from April 8 to May 8.

ANIMAS RIVER AT DURANGO, COLORADO.

This stream is the largest tributary of the San Juan, and derives its water from the high mountains above Silverton, draining portions of the Needle and La Plata mountains in addition to those at its source. It flows in a southerly direction for about 60 miles, crossing the Colorado line about 15 miles south of Durango. Most of its course is through a very mountainous country, but in the vicinity of Hermosa it issues from the canyon into a broad valley, which is extensively irrigated. A canal line has been projected from the lower part of the stream, for the purpose of irrigating lands in New Mexico, but the canal has not yet been finished. The station was first established June 20, 1895, and has been maintained during the greater part of each year since. It is at a wagon bridge a quarter of a mile west of the depot of the Denver and Rio Grande Railroad. The rod, which is a vertical piece of timber marked in feet and tenths, is fastened to the central pier of the bridge. On June 25, 1900, it was checked against a bench mark—a point chiseled on the lower side of the left-hand abutment of the bridge 16.84 feet above the zero of the rod. Lightner Creek enters the river from the right, about 100 feet below the bridge. The channel at the station is straight, the bed is of gravel and bowlders, and the banks are sufficiently high so that there is little danger of overflow. The observer is C. G. Graden, of Durango. A description of the station was published in Water-Supply Paper No. 38, page 310. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 301. During 1900 the following measurements were made by A. L. Fellows:

March 26: Gage height, 6.60 feet; discharge, 246 second-feet.
May 9: Gage height, 8.65 feet; discharge, 1,614 second-feet.
June 25: Gage height, 8.80 feet: discharge, 1,740 second-feet.
August 13: Gage height, 6.45 feet; discharge, 169 second-feet.

Daily gage height, in feet, of Animas River at Durango, Colorado, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.60	.....	.....	6.60	7.25	10.30	7.70	6.60	6.30	6.50	.....	6.50
2	.....	.....	.....	6.80	7.20	9.95	7.60	6.60	6.30	6.60	.....	.....
3	.....	6.30	6.20	6.80	7.20	10.00	7.60	6.50	6.30	6.60	6.60	.....
4	.....	.....	.....	6.80	7.35	9.90	7.50	6.50	6.40	6.70	.....	6.50
5	.....	.....	.....	6.80	7.75	9.70	7.50	6.50	6.40	6.70	6.50	.....
6	6.40	.....	6.20	6.70	7.80	9.70	7.30	6.50	6.40	6.70	.....	.....
7	.....	.....	.....	6.60	7.85	9.85	7.20	6.50	6.50	.....	.....	.....
8	.....	.....	.....	6.80	8.10	9.70	7.10	6.50	6.80	6.80	.....	.....
9	6.50	.....	.....	6.80	8.55	9.60	7.10	6.50	7.00	.....	.....	.....
10	.....	6.30	6.30	6.70	9.05	9.30	7.10	6.50	7.00	.....	6.50	.....
11	.....	.....	.....	6.70	9.20	8.95	7.10	6.50	6.90	6.70	.....	6.50
12	.....	.....	6.50	6.70	9.15	8.70	7.10	6.50	6.80	.....	.....	.....
13	6.40	.....	6.50	6.70	8.95	8.70	7.00	6.50	6.70	6.60	.....	.....
14	.....	.....	6.60	6.70	8.95	8.95	7.00	6.50	6.60	6.60	6.50	.....
15	.....	.....	6.60	6.70	9.10	8.95	7.00	6.50	6.60	6.60	.....	6.70
16	6.50	.....	6.60	6.70	9.60	9.00	6.90	6.50	6.60	.....	.....	.....
17	.....	6.20	6.50	6.70	9.90	9.10	6.90	6.40	6.60	6.60	6.50	.....
18	.....	.....	6.60	6.70	10.15	8.90	6.90	6.40	6.50	.....	.....	.....
19	.....	.....	6.60	6.70	9.90	8.70	6.80	6.40	6.50	.....	.....	6.50
20	6.30	.....	6.70	6.80	9.60	8.65	6.80	6.40	6.50	6.60	6.50	.....
21	.....	.....	6.70	6.90	9.05	8.65	6.80	6.40	6.50	.....	.....	.....
22	.....	.....	6.70	7.10	9.05	8.65	6.80	6.30	6.50	.....	.....	6.60
23	6.40	.....	6.70	7.10	9.65	8.65	6.70	6.30	6.50	.....	.....	.....
24	.....	6.20	6.70	7.10	10.30	8.70	6.70	6.30	6.50	6.70	6.50	.....
25	.....	.....	6.60	7.10	9.80	8.65	6.70	6.30	6.60	.....	.....	6.50
26	.....	.....	6.60	7.10	10.05	8.50	6.70	6.30	6.70	.....	.....	.....
27	6.30	.....	6.60	7.10	10.50	8.20	6.70	6.30	6.70	6.70	6.50	.....
28	.....	.....	6.70	7.10	10.55	8.00	6.70	6.30	6.60	.....	.....	.....
29	.....	.....	6.50	7.20	10.30	7.90	6.60	6.30	6.50	.....	.....	6.50
30	.....	.....	6.50	7.15	10.30	7.70	6.60	6.30	6.50	.....	6.50	.....
31	.....	.....	6.60	.....	10.30	.....	6.60	6.30	.....	6.60	.....	.....

MANCOS RIVER AT MANCOS, COLORADO.

This stream, an important tributary of the San Juan, drains a portion of the southwestern corner of Colorado. It rises on the western slope of the La Plata Mountains, and flows in a southwesterly direction, through a mountainous country, for about 12 miles, to the Mancos Valley, a broad and fertile tract irrigated by water taken from the river. The next 12 miles of its course is through Mancos Valley. It then enters Mancos Canyon, cut through the Mesa Verde, through which it flows for about 40 miles, or to its junction with the San Juan. The normal supply of the river is exhausted, but sufficient water goes to waste in the flood season to irrigate all of the available land along its borders.

The station at Mancos was established April 9, 1898, for the purpose of determining the amount of water going to waste during high-water periods. The rod, which is a 2-inch by 4-inch timber marked in feet and tenths, is fastened to a tree about 100 feet below the wagon bridge crossing the river in the center of the town. The channel is of bowlders and gravel, and the banks are sufficiently high so that there is little danger of overflow. During 1900 the bed of the stream shifted to such an extent that a rating table for that year is impossible. The observer is Mrs. W. H. Kelley, of Mancos. A description of the station was published in Water-Supply Paper No. 38, page 312. The results of measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 285.

During 1900 the following measurements were made by A. L. Fellows:

March 23: Gage height, 1.05 feet; discharge, 4 second-feet.
May 7: Gage height, 1.80 feet; discharge, 82 second-feet.
June 26: Gage height, 1.70 feet; discharge, 16 second-feet.
August 12: Gage height, 1.40 feet; discharge, 2 second-feet.

Daily gage height, in feet, of Mancos River at Mancos, Colorado, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.00	1.90	2.90	1.60	1.40	1.30	2.00	1.60
2	1.00	1.90	2.90	1.60	1.40	2.00	2.00	1.60
3	1.00	2.00	2.80	1.60	1.40	1.90	1.80	1.60
4	1.00	2.05	2.80	1.60	1.40	1.90	1.80	.....
5	1.10	2.20	2.50	1.60	1.50	1.80	1.90	.....
6	1.10	2.20	2.50	1.60	1.60	1.80	2.00	.....
7	1.10	2.40	2.50	1.50	1.60	1.90	2.00	.....
8	1.10	2.70	2.50	1.50	1.50	2.10	1.80	.....
9	1.10	2.70	2.50	1.50	1.50	2.00	1.80	.....
10	1.10	2.70	2.40	1.50	1.50	2.00	1.80	.....
11	1.20	2.70	2.30	1.40	1.40	2.00	1.80	.....
12	1.20	2.70	2.30	1.40	1.40	1.80	1.80	.....
13	1.20	2.70	2.20	1.40	1.40	1.80	1.80	.....
14	1.20	2.70	1.90	1.40	1.40	1.60	1.70	.....
15	1.20	2.70	1.90	1.40	1.50	1.50	1.60	.....
16	1.20	2.70	1.90	1.40	1.50	1.50	1.60	.....
17	1.30	2.70	1.80	1.30	1.50	1.50	1.60	.....
18	1.30	2.80	1.80	1.30	1.50	1.50	1.60	.....
19	1.40	2.80	1.70	1.30	1.50	1.50	1.60	.....
20	1.60	2.85	1.70	1.40	1.65	1.50	1.80	.....
21	1.70	2.90	1.70	1.40	1.70	1.50	1.70	.....
22	2.00	2.80	1.70	1.20	1.50	1.40	1.60	.....
23	2.05	2.80	1.80	1.20	1.40	1.60	1.60	.....
24	2.00	2.85	1.70	1.10	1.40	1.80	1.60	.....
25	2.00	2.90	1.70	1.10	1.40	2.00	1.60	.....
26	2.00	2.85	1.70	.70	1.40	2.00	1.70	.....
27	1.90	2.95	1.80	.70	1.30	1.80	1.70	.....
28	1.90	2.90	1.70	.70	1.20	1.80	1.60	.....
29	1.90	2.90	1.70	.70	1.20	1.80	1.60	.....
30	1.90	2.90	1.60	1.20	1.10	1.80	1.60	.....
31	.....	2.90	.....	1.30	1.20	.....	1.60	.....

GILA RIVER AT SAN CARLOS, ARIZONA.

This station was established by C. C. Babb on July 11, 1899, in connection with an investigation of Gila River with reference to a supply of water for the Gila River Indian Reservation and arid lands in the vicinity. Results of this investigation were published in Water-Supply Paper No. 33, entitled, Storage of Water on Gila River, Arizona, by J. B. Lippincott. The station is a half mile south of the Indian agency at San Carlos, below the mouth of San Carlos Creek, and about 6 miles above the proposed dam site. It is described in Water-Supply Paper No. 38, page 313. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page

332. During 1900 the following measurements of discharge were made by Stephen Janus:

Discharge measurements of Gila River at San Carlos, Arizona.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
May 1	1.50	7.0	August 18	2.25	230
May 12	1.30	6.2	August 19	2.50	384
May 19	1.30	4.0	August 20	1.80	139
May 26	1.30	2.5	August 26	1.00	14
June 9	1.10	.8	September 3	1.85	175
June 16	1.10	1.5	September 7	3.60	2,840
June 23	*a* .25	.9	Do		141
June 30	*a* .20	.5	September 11	3.40	1,952
July 7	*a* .15	.3	September 18	1.80	194
July 14	*a* .15	.3	October 6	1.30	64
July 21	*a* .25	.8	October 25	1.30	55
July 28	*a* .30	4.7	November 18	1.60	67
August 3	2.50	320.3	November 20	3.60	1,927
August 7	0.00	29.7	December 21	1.65	106
August 12	*a* .30	2.3	December 31	1.75	67

a Dry at gage; figures indicate depth, not gage height.

Daily gage height, in feet, of Gila River at San Carlos, Arizona, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.45	1.30	(*a*)	(*a*)	1.50	1.60	1.25	1.50
2		1.40	1.30	(*a*)	(*a*)	1.95	1.50	1.25	1.50
3		1.40	1.20	(*a*)	2.60	1.85	1.40	1.25	1.60
4	1.50	1.40	1.20	(*a*)	(*a*)	1.20	1.35	1.25	1.70
5	1.60	1.40	1.20	(*a*)	(*a*)		1.40	1.25	1.70
6	1.60	1.35	1.20	(*a*)	(*a*)		1.40	1.20	1.70
7	1.60	1.35	1.20	(*a*)	(*a*)	3.70	1.50	1.20	1.65
8	1.60	1.30	1.10	(*a*)	(*a*)	3.45	1.45	1.15	1.60
9	1.60	1.30	1.10	(*a*)	(*a*)	4.95	1.30	1.15	1.60
10	1.60	1.30	1.10	(*a*)	(*a*)	4.70	1.30	1.10	1.60
11	1.55	1.30	1.10	(*a*)	(*a*)	3.20	1.30	1.10	1.60
12	1.55	1.30	1.10	(*a*)	(*a*)	2.60	1.20	1.10	1.60
13	1.60	1.30	1.10	(*a*)	(*a*)	2.30	1.30	1.00	1.60
14	1.60	1.30	1.10	(*a*)	(*a*)	2.10	1.30	1.00	1.70
15	1.60	1.30	1.10	(*a*)	(*a*)	2.00	1.30	.95	1.70
16	1.60	1.30	1.10	(*a*)	(*a*)	1.90	1.20	.90	1.70
17	1.60	1.35	(*a*)	(*a*)	4.00	1.85	1.20	.90	1.70
18	1.50	1.35	(*a*)	(*a*)	3.30	1.75	1.15	1.75	1.70
19	1.40	1.35	(*a*)	(*a*)	2.80	1.50	1.10	2.85	1.70
20	1.40	1.35	(*a*)	(*a*)	2.00	1.40	1.50	3.95	1.70
21	1.40	1.35	(*a*)	(*a*)	1.60	1.40	1.50	2.20	1.70
22	1.40	1.35	(*a*)	(*a*)	1.30	1.45	1.40	1.75	1.70
23	1.40	1.30	(*a*)	(*a*)	1.20	3.15	1.40	1.65	1.70
24	1.40	1.30	(*a*)	(*a*)	1.20	3.35	1.40	1.60	1.70
25	1.40	1.30	(*a*)	(*a*)	1.20	2.90	1.35	1.60	1.70
26	1.40	1.30	(*a*)	(*a*)	1.10	2.45	1.30	1.55	1.70
27	1.40	1.30	(*a*)	(*a*)	1.10	2.20	1.30	1.55	1.70
28	1.50	1.30	(*a*)	(*a*)	1.10	1.85	1.25	1.55	1.70
29	1.50	1.30	(*a*)	(*a*)	1.10	1.80	1.25	1.55	1.70
30	1.50	1.30	(*a*)	(*a*)	1.10	1.70	1.25	1.55	1.75
31		1.30		(*a*)	1.10		1.25		1.75

a River dry at gage rod.

SALT RIVER AT McDOWELL, ARIZONA.

This station, established April 20, 1897, is a half mile above the mouth of Verde River. It is described in Water-Supply Paper No. 38, page 321. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 386. The station was discontinued November 30, 1899, and was not resumed during 1900.

Observations will be maintained here, however, during 1901, in connection with an investigation of the river with reference to a water supply for arid lands in the vicinity.

VERDE RIVER AT McDOWELL, ARIZONA.

This station, established April 20, 1897, is three-fourths of a mile above the mouth of the river. It is described in Water-Supply Paper No. 38, page 323. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 387. The station was discontinued November 11, 1899, and was not maintained during 1900. Observations will, however, be resumed during 1901.

COLORADO RIVER AT YUMA, ARIZONA.

This station was established in April, 1878, by the Southern Pacific Railway Company, who have maintained daily readings since that time. It is through the courtesy of that company that the records are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 38, page 324. No measurements of discharge were made during 1900.

Daily gage height, in feet, of Colorado River at Yuma, Arizona, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17.8	18.3	17.7	19.4	19.7	24.6	23.0	17.6	16.9	17.0	17.6	17.8
2	17.8	18.3	17.8	19.3	19.7	24.8	22.8	18.0	16.8	16.9	17.6	17.7
3	17.7	18.3	17.8	19.3	20.5	25.0	22.7	17.4	16.7	16.8	17.5	17.4
4	17.5	18.2	17.8	19.3	20.5	25.2	22.3	17.3	16.6	16.7	17.4	17.7
5	17.4	18.1	17.7	19.3	20.5	25.3	22.0	17.3	16.5	16.8	17.5	17.7
6	17.3	18.0	17.7	19.4	20.1	25.5	21.7	17.2	16.6	16.8	17.4	17.7
7	17.2	18.1	17.6	19.5	20.3	25.7	21.6	17.1	16.5	16.8	17.4	17.7
8	17.2	18.0	17.7	19.4	20.3	25.8	21.3	17.2	16.5	16.9	17.4	17.7
9	17.2	18.0	17.8	19.3	20.3	26.0	21.2	17.2	16.5	17.3	17.4	17.7
10	17.2	17.9	17.8	19.3	20.5	26.0	20.7	17.2	16.4	17.3	17.5	17.7
11	17.3	17.9	17.7	19.4	20.7	26.0	20.5	17.2	16.4	17.2	17.5	17.7
12	17.3	17.8	17.7	19.4	21.0	25.9	20.3	17.3	16.6	17.2	17.5	17.7
13	17.4	17.7	17.7	19.3	21.3	25.7	20.2	17.2	17.3	17.2	17.5	17.7
14	17.4	17.8	17.8	19.2	21.4	25.5	19.8	16.9	18.0	17.3	17.5	17.7
15	17.4	17.8	17.8	19.2	21.6	25.4	19.7	16.8	17.7	17.3	17.5	17.7
16	17.7	17.7	18.0	19.2	21.7	25.3	19.6	16.9	17.5	17.3	17.5	17.7
17	17.8	17.8	18.0	19.5	22.3	25.2	19.5	16.7	17.7	17.3	17.5	17.6
18	18.1	17.8	18.1	19.5	22.9	24.8	19.2	16.7	17.4	17.3	17.6	17.4
19	18.2	17.8	18.2	19.4	23.4	24.7	19.0	16.7	17.7	17.4	17.5	17.4
20	18.3	17.8	18.3	19.5	23.7	24.5	18.9	16.8	18.1	17.3	17.6	17.4
21	18.3	17.8	18.3	19.8	23.8	24.2	18.8	16.8	17.8	17.3	17.7	17.4
22	18.3	17.7	18.5	20.3	24.0	24.2	18.8	16.8	17.7	17.3	17.7	17.4
23	18.3	17.7	18.5	20.2	24.0	24.0	18.5	16.8	17.4	17.6	17.7	17.5
24	18.2	17.7	18.5	20.3	24.2	23.9	18.4	16.8	17.3	17.6	18.1	17.5
25	18.2	17.7	18.6	19.9	24.4	23.8	18.3	16.9	17.2	17.7	18.3	17.5
26	18.2	17.7	18.6	19.8	24.7	23.7	18.3	16.9	17.2	17.8	18.6	17.5
27	18.2	17.8	18.7	19.7	24.7	23.4	18.2	16.8	17.0	17.8	18.7	17.5
28	18.2	17.8	19.2	19.7	24.5	23.3	18.0	16.9	17.0	17.7	17.9	17.4
29	18.3	.....	19.8	19.7	24.2	23.1	17.9	16.7	17.0	17.6	17.6	17.3
30	18.3	.....	19.7	19.7	24.2	23.1	17.8	16.7	17.0	17.6	17.7	17.2
31	18.3	.....	19.6	.....	24.4	.....	17.7	16.7	.....	17.6	.....	17.1

[Continued in Water-Supply Paper No. 51.]

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DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 51

OPERATIONS AT RIVER STATIONS, 1900.—PART V

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1900

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART V

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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OPERATIONS AT RIVER STATIONS, 1900.

PART V.

MEASUREMENTS AT RIVER STATIONS.[1]

NORTH FORK OF HUMBOLDT RIVER NEAR PEKO, NEVADA.

This station, established March 25, 1898, is on the Southern Pacific Railroad bridge about 2 miles west of Peko and a short distance above the mouth of the river. It is described in Water-Supply Paper No. 38, page 325. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 389. The station was discontinued March 3, 1900, and no measurements of discharge were made during the year.

Daily gage height, in feet, of North Fork of Humboldt River near Peko, Nevada, for 1900.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	2.3	3.3	3.5	12	3.1	3.3	.....	23	3.1	3.5	.....
2	2.4	3.3	3.5	13	3.2	3.3	.....	24	3.2	3.5	.....
3	2.5	3.3	3.5	14	3.1	3.3	.....	25	3.2	3.5	.....
4	2.5	3.3	.....	15	3.2	3.3	.....	26	3.2	3.5	.....
5	2.5	3.3	.....	16	3.2	3.4	.....	27	3.2	3.5	.....
6	2.5	3.3	.....	17	3.2	3.4	.....	28	3.2	3.5	.....
7	3.0	3.3	.....	18	3.3	3.3	.....	29	3.2	.....	.....
8	3.0	3.4	.....	19	3.3	3.4	.....	30	3.2	.....	.....
9	3.0	3.4	.....	20	3.3	3.4	.....	31	3.3	.....	.....
10	3.0	3.4	.....	21	3.1	3.4	.....				
11	3.1	3.3	.....	22	3.1	3.4	.....				

HUMBOLDT RIVER NEAR ELKO, NEVADA.

This station, established by L. H. Taylor on June 17, 1895, is at the highway bridge 1 mile southwest of the town. It is described in Water-Supply Paper No. 38, page 326. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 390. During 1900 the following measurements of discharge were made by L. H. Taylor:

July 6: Gage height, 2 feet; discharge, 22 second-feet.
August 31: Gage height, 1.75 feet; discharge, 4 second-feet.

[1] Continued from Water-Supply and Irrigation Paper No. 50.

Daily gage height, in feet, of Humboldt River near Elko, Nevada, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.38	2.90	3.09	2.85	3.70	4.55	3.00	1.95	1.80	1.85	1.92	2.30
2	2.40	2.95	3.00	2.90	3.70	4.60	3.00	1.90	1.80	1.85	1.94	2.30
3	2.41	3.00	3.10	3.00	3.65	4.70	2.10	1.85	1.79	1.86	1.92	2.30
4	2.42	3.00	3.25	2.95	3.65	4.75	2.80	1.80	1.80	1.87	1.95	2.30
5	2.43	2.95	3.20	2.87	3.75	4.80	2.60	1.75	1.80	1.85	1.94	2.30
6	2.45	2.85	3.15	2.85	3.60	4.85	2.40	1.70	1.80	1.85	2.00	2.30
7	2.48	2.70	3.10	2.90	3.55	4.88	2.20	1.65	1.79	1.85	2.04	2.30
8	2.49	2.67	3.13	2.95	3.55	4.90	3.30	1.60	1.80	1.85	2.05	2.30
9	2.50	2.65	3.07	3.00	3.50	4.95	3.75	1.55	1.80	1.90	2.10	2.30
10	2.52	2.60	3.05	2.95	3.55	5.30	2.75	1.55	1.79	1.85	2.10	2.30
11	2.54	2.65	3.00	2.98	3.60	5.25	2.60	1.55	1.80	1.90	2.05	2.30
12	2.55	2.55	3.05	3.01	3.65	5.20	2.75	1.50	1.80	1.90	2.10	2.34
13	2.54	2.58	3.05	2.95	4.25	5.15	2.80	1.50	1.79	1.90	2.14	2.34
14	2.65	2.66	3.10	2.80	4.35	5.05	2.60	1.45	1.80	1.90	2.15	2.35
15	2.75	2.68	3.15	3.00	4.45	5.07	2.50	1.50	1.80	1.90	2.18	2.35
16	2.90	2.75	3.25	3.15	4.75	5.10	2.45	1.55	1.80	1.94	2.18	2.30
17	3.10	2.85	3.20	3.20	4.85	5.10	2.45	1.60	1.78	1.94	2.20	2.35
18	3.30	2.75	3.20	3.25	4.65	5.05	2.45	1.60	1.78	1.93	2.30	2.35
19	3.20	2.80	3.15	3.30	4.45	5.10	2.45	1.60	1.80	1.94	2.30	2.35
20	3.00	2.85	3.10	3.35	4.30	4.95	2.43	1.55	1.82	1.90	2.30	2.35
21	3.00	2.90	2.95	3.35	4.58	4.90	2.40	1.55	1.84	1.90	2.30	2.37
22	2.90	2.98	2.80	3.25	4.55	4.80	2.35	1.55	1.85	1.94	2.30	2.40
23	2.85	3.00	2.95	3.30	4.53	4.75	2.30	1.50	1.85	1.93	2.25	2.40
24	2.75	3.08	2.95	3.35	4.53	4.40	2.25	1.45	1.87	1.92	2.25	2.40
25	2.80	3.00	2.85	3.38	4.53	4.15	2.15	1.40	1.90	1.90	2.30	2.40
26	3.15	3.15	2.80	3.40	4.47	4.00	2.10	1.45	1.87	1.90	2.30	2.40
27	3.20	3.20	2.85	3.45	4.45	3.90	2.05	1.50	1.86	1.90	2.25	2.40
28	3.10	3.15	2.90	3.55	4.50	3.85	2.05	1.55	1.87	1.90	2.25	2.40
29	3.00	.....	2.85	3.60	4.45	3.90	2.05	1.60	1.90	1.90	2.28	2.40
30	2.95	.....	2.85	3.85	4.35	3.85	2.00	1.65	1.87	1.90	2.29	2.37
31	2.85	.....	2.80	.....	4.25	.....	2.00	1.75	.....	1.92	.....	2.35

SOUTH FORK OF HUMBOLDT RIVER AT MASON'S RANCH, NEVADA.

This station, established August 29, 1896, is 10 miles southwest of the town of Elko. It is described in Water-Supply Paper No. 38, page 327. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 311; for 1897, Nineteenth Annual Report, Part IV, page 430; for 1898, Twentieth Annual Report, Part IV, page 440; for 1899, Twenty-first Annual Report, Part IV, page 391. During 1900 the following measurements were made by L. H. Taylor:

July 6: Gage height, 1.45 feet; discharge, 150 second-feet.
August 31: Gage height, 0.80 foot; discharge, 0.60 second-foot.

Daily gage height, in feet, of South Fork of Humboldt River at Mason's ranch, Nevada, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.95	0.70	1.10	1.35	1.60	3.50	1.85	0.55	0.30	0.40	0.75	0.95
2	.95	.70	1.10	1.35	1.65	3.50	1.70	.50	.30	.45	.75	.90
3	.95	.70	1.10	1.35	1.70	3.20	1.70	.45	.30	.45	.75	.90
4	.95	.70	1.10	1.35	1.70	3.30	1.60	.45	.30	.50	.75	.90
5	.95	.70	1.10	1.35	1.80	3.30	1.55	.40	.30	.50	.75	.85
6	.95	.80	1.10	1.35	1.95	3.35	1.45	.40	.30	.50	.75	.85
7	.95	.85	1.10	1.35	2.00	3.40	1.40	.40	.30	.50	.75	.85
8	.95	.85	1.10	1.45	2.20	3.50	1.35	.35	.30	.50	.75	.85
9	.95	.90	1.10	1.50	2.30	3.50	1.35	.35	.30	.50	.75	.80
10	.95	.90	1.10	1.50	2.50	3.60	1.30	.35	.30	.50	.75	.80
11	.95	.90	1.10	1.60	2.60	3.40	1.25	.35	.30	.50	.75	.80
12	.95	.90	1.10	1.60	2.75	3.30	1.20	.35	.30	.50	.75	.80
13	.95	.90	1.20	1.60	2.80	3.20	1.20	.35	.30	.50	.75	.80
14	1.00	.95	1.20	1.60	2.80	3.10	1.15	.35	.30	.55	.75	.80
15	1.20	.95	1.20	1.60	2.75	3.10	1.10	.35	.30	.55	.75	.80
16	1.20	.90	1.25	1.60	2.75	3.10	1.00	.35	.30	.55	.75	.80
17	1.30	.90	1.25	1.55	2.75	2.90	.90	.35	.30	.60	.75	.80
18	1.30	.95	1.25	1.50	2.80	2.60	.90	.35	.35	.60	.80	.80
19	1.30	.95	1.25	1.50	2.80	2.50	.85	.30	.35	.65	.80	.80
20	1.10	1.00	1.30	1.50	2.75	2.50	.80	.30	.35	.65	.90	.80
21	.90	1.00	1.30	1.50	2.75	2.50	.80	.30	.35	.65	.90	.80
22	.90	1.10	1.35	1.50	2.75	2.45	.75	.30	.35	.65	.90	.80
23	.90	1.10	1.35	1.50	2.80	2.40	.70	.30	.35	.70	.90	.70
24	.90	1.10	1.35	1.45	2.85	2.30	.70	.30	.35	.70	.90	.70
25	.80	1.10	1.35	1.45	2.85	2.20	.70	.30	.40	.70	.95	.65
26	.80	1.10	1.35	1.45	2.90	2.10	.70	.30	.40	.70	.95	.65
27	.80	1.10	1.35	1.45	3.35	2.10	.70	.30	.40	.70	.95	.65
28	.75	1.10	1.35	1.45	3.40	2.10	.70	.30	.40	.75	.95	.60
29	.75	------	1.35	1.50	3.40	2.00	.65	.30	.40	.75	.95	.60
30	.70	------	1.35	1.60	3.40	1.90	.65	.30	.40	.75	.95	.60
31	.70	------	1.35	------	3.50	------	.60	.30	------	.75	------	.60

HUMBOLDT RIVER NEAR GOLCONDA, NEVADA.

This station is near the great northern bend of Humboldt River, and below the central valley. It is about 12 miles above the mouth of Little Humboldt River. It was established October 24, 1894, and is described in Water-Supply Paper No. 38, page 329. The results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 306; for 1897, Nineteenth Annual Report, Part IV, page 427; for 1898, Twentieth Annual Report, Part IV, page 438; for 1899, Twenty-first Annual Report, Part IV, page 392. During 1900 the following measurements were made by L. H. Taylor:

April 14: Gage height, 1.75 feet; discharge, 102 second-feet.
May 25: Gage height, 3.83 feet; discharge, 385 second-feet.
July 13: Gage height, 1.50 feet; discharge, 66 second-feet.
August 30: Gage height, 0.20 foot; discharge, 2.5 second-feet.

Daily gage height, in feet, of Humboldt River near Golconda, Nevada, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	2.90	3.30	2.65	1.80	3.80	2.90	0.45	0.20	0.20	0.20	0.15
2	2.25	2.90	3.30	2.60	1.80	3.75	2.80	.45	.20	.20	.20	.15
3	2.25	2.90	3.30	2.50	1.80	3.75	2.70	.40	.20	.20	.20	.20
4	2.30	2.90	3.35	2.20	1.75	3.75	2.50	.40	.20	.20	.20	.20
5	2.40	2.90	3.35	2.00	1.70	3.80	2.30	.40	.20	.20	.20	.20
6	2.40	2.95	3.35	1.85	1.60	3.82	2.20	.35	.20	.20	.20	.20
7	2.45	2.95	3.35	1.75	1.50	3.90	2.10	.35	.20	.20	.20	.20
8	2.45	2.95	3.30	1.65	1.50	4.10	2.00	.30	.20	.20	.20	.25
9	2.45	2.95	3.25	1.65	1.50	4.10	2.00	.30	.20	.20	.20	.25
10	2.50	3.00	3.20	1.70	1.50	3.95	1.90	.25	.20	.20	.20	.30
11	2.50	3.00	3.20	1.75	1.50	4.05	1.70	.20	.20	.20	.20	.35
12	2.50	3.00	3.20	1.70	1.50	4.10	1.60	.20	.20	.20	.20	.35
13	2.55	3.05	3.15	1.75	1.50	4.20	1.50	.20	.20	.20	.20	.40
14	2.55	3.05	3.15	1.75	1.50	4.25	1.40	.20	.20	.20	.20	.50
15	2.55	3.10	3.10	1.75	1.50	4.30	1.30	.20	.20	.20	.20	.55
16	2.60	3.10	3.10	1.75	1.80	4.30	1.20	.20	.20	.20	.20	.60
17	2.60	3.15	3.10	1.75	2.10	4.10	1.10	.20	.20	.20	.20	.60
18	2.65	3.15	3.10	1.75	2.25	3.90	1.00	.20	.20	.20	.20	.70
19	2.65	3.15	3.05	1.75	2.45	3.70	.90	.20	.20	.20	.20	.75
20	2.70	3.20	3.00	1.75	3.30	3.50	.80	.20	.20	.20	.20	.80
21	2.70	3.20	3.00	1.75	3.45	3.40	.80	.20	.20	.20	.20	.90
22	2.70	3.20	2.90	1.75	3.55	3.40	.80	.20	.20	.20	.20	.90
23	2.75	3.25	2.90	1.75	3.60	3.30	.70	.20	.20	.20	.20	.95
24	2.75	3.25	2.85	1.80	3.70	3.30	.70	.20	.20	.20	.20	.95
25	2.80	3.25	2.85	1.80	3.83	3.30	.60	.20	.20	.20	.15	.95
26	2.80	3.25	2.85	1.80	3.85	3.20	.60	.20	.20	.20	.15	.95
27	2.80	3.30	2.80	1.80	3.90	3.10	.60	.20	.20	.20	.15	.95
28	2.80	3.30	2.80	1.80	3.90	3.00	.50	.20	.20	.20	.15	1.00
29	2.85	.....	2.75	1.80	3.90	2.90	.50	.20	.20	.20	.15	1.00
30	2.85	.....	2.70	1.80	3.90	2.90	.50	.20	.20	.20	.15	1.00
31	2.85	.....	2.70	.....	3.85	.....	.45	.20	.....	.20	.....	1.00

HUMBOLDT RIVER NEAR OREANA, NEVADA.

This station, established January 27, 1896, is 1½ miles above the old Oreana highway bridge. It is 12 miles northeast of Lovelocks and above all of the canals diverting water in the vicinity of that town. It is described in Water-Supply Paper No. 38, page 330. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 307; for 1897, Nineteenth Annual Report, Part IV, page 428; for 1898, Twentieth Annual Report, Part IV, page 439; for 1899, Twenty-first Annual Report, Part IV, page 393. During 1900 the following measurements of discharge were made by L. H. Taylor:

Discharge measurements of Humboldt River near Oreana, Nevada.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
March 2	1.95	267	May 23	0.20	26
April 4	1.50	157	June 29	1.65	190
April 7	1.30	124	July 8	2.00	283
May 1	.40	47			

Daily gage height, in feet, of Humboldt River near Oreana, Nevada, for 1900.

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	1.90	2.00	1.60	0.40	0.70	1.50	0.90	0.20	0.20	0.40	0.30
2	2.40	1.80	2.00	1.60	.40	.80	1.70	.70	.20	.20	.40	.30
3	2.40	1.80	2.00	1.50	.40	.20	1.90	.80	.20	.20	.40	.30
4	a2.60	1.90	2.00	1.50	.40	.20	2.00	.80	.20	.50	.40	.30
5	a2.60	1.90	2.00	1.50	.40	.20	2.10	.80	.10	.40	.40	.30
6	a2.60	2.00	2.00	1.30	.40	.30	2.20	.80	.10	.40	.40	.30
7	a2.60	2.00	2.10	1.30	.40	.40	2.00	.70	.10	.30	.50	.30
8	a2.60	2.00	2.10	1.40	.40	.50	2.00	.60	.10	.40	.50	.30
9	a3.00	1.90	2.10	1.40	.40	.50	2.00	.60	.10	.40	.40	.30
10	a3.00	1.90	2.10	1.30	.40	.80	1.90	.60	.10	.40	.40	.30
11	a3.80	1.90	2.10	1.30	.35	.80	1.80	.50	.10	.30	.40	.40
12	a4.00	1.90	2.10	1.00	.35	.80	1.80	.50	.10	.30	.40	.50
13	1.80	1.80	2.00	.90	.35	1.50	1.70	.50	.10	.30	.50	.50
14	2.00	1.70	2.00	.90	.30	1.20	1.70	.50	.60	.30	.50	.30
15	2.00	1.70	2.00	.90	.30	1.10	1.70	.50	.50	.30	.50	.30
16	1.80	1.70	1.90	.90	.25	1.10	1.70	.50	.40	.40	.50	.30
17	1.80	1.70	1.90	.80	.25	1.10	1.60	.50	.40	.40	.40	.30
18	1.80	1.90	1.90	.80	.25	1.10	1.60	.50	.40	.40	.40	.30
19	1.70	1.90	1.90	.50	.20	1.30	1.50	.50	.30	.30	.40	.30
20	1.60	1.90	1.90	.50	.20	1.40	1.30	.40	.30	.30	.50	.30
21	1.80	2.00	1.80	.50	.20	1.70	1.30	.40	.30	.30	.00	.30
22	1.80	2.00	1.80	.50	.20	1.70	1.30	.30	.20	.30	.60	.30
23	1.80	2.00	1.80	.50	.20	1.50	1.30	.30	.20	.30	.60	.30
24	1.80	1.90	1.80	.40	.20	1.50	1.30	.30	.20	.40	.50	.30
25	1.70	1.90	1.80	.40	.20	1.50	1.20	.30	.20	.40	.50	.70
26	1.70	1.90	1.80	.40	.20	1.70	1.20	.30	.20	.40	.50	.70
27	1.70	1.90	1.60	.40	.20	1.90	.90	.30	.20	.40	.50	1.00
28	1.80	2.00	1.60	.40	.20	2.00	.80	.30	.20	.40	.40	1.00
29	1.90	.....	1.60	.40	.20	1.80	1.40	.30	.20	.40	.40	1.40
30	1.90	.....	1.30	.40	.40	1.50	1.30	.20	.20	.40	.30	1.40
31	1.90	.....	1.30	.....	.50	.....	1.30	.20	.....	.40	.....	1.40

a Ice gorge below gage; actual height should be 2.40.

The following table gives the discharge measurements of the canals diverting water from Humboldt River near Lovelocks:

Discharge measurements of canals near Lovelocks, Nevada.

Date.	Canal.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
March 16	Old Channel ditch	At head gate	L. H. Taylor	94
March 19	do	do	do	80
June 29	do	250 yards below head gate.	do	60
March 16	Last Chance ditch	About 1 mile below head.	do	41
March 19	do	do	do	39
April 7	do	do	do	8
June 29	do	do	do	17
March 16	Southwest ditch	do	do	32
March 19	do	do	do	34
April 7	do	do	do	34
June 29	do	do	do	30
March 8	Marker or Rodgers ditch.	At flume across Humboldt River.	do	49
March 16	do	do	do	56
March 19	do	do	do	60
April 7	do	do	do	56
June 29	do	do	do	55
March 17	Union canal	At head gate	do	31
March 19	do	do	do	28
April 7	do	do	do	31
June 29	do	do	do	28

EAST FORK CARSON RIVER NEAR GARDNERVILLE, NEVADA.

This branch of Carson River has its source in the high Sierra of California, and flows northward, crossing the Nevada-California

boundary line and entering Carson Valley at Rodenbah's ranch, about 20 miles a little east of south from Carson. There it turns to the northwest, and a short distance above the town of Genoa unites with the West Fork, forming Carson River. The drainage area above Rodenbah's is 414 square miles in extent, and is mapped on the Markleeville and Dardanelles atlas sheets of the United States Geological Survey. The gaging station was established by L. H. Taylor on October 17, 1900, at the place where measurements were made in the years 1890, 1891, and 1892, the results of which are given in the Thirteenth Annual Report, Part III, page 95. The rod is an inclined timber securely fastened to posts set in the right bank of the stream. The bench mark is on a basalt rock in the edge of the stream, 20 feet from the gage, and is at an elevation of 6.3 feet above gage datum. The channel at the station is straight and the banks are high. The stream bed is of cobbles and gravel, and is quite stable. Measurements are made from a cable and suspended car.

Daily gage height, in feet, of East Fork Carson River near Gardnerville, Nevada, for 1900.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	2.4	2.4	12	.....	2.4	2.3	23	2.6	2.7	2.4
2	.....	2.4	2.4	13	.....	2.4	2.4	24	2.5	2.7	2.4
3	.....	2.4	2.4	14	.....	2.4	2.4	25	2.5	2.7	2.4
4	.....	2.3	2.4	15	.....	2.4	2.4	26	2.5	2.6	2.4
5	.....	2.3	2.4	16	.....	2.3	2.4	27	2.4	2.4	2.4
6	.....	2.3	2.4	17	2.3	2.4	2.4	28	2.4	2.4	2.4
7	.....	2.3	2.3	18	2.3	2.4	2.4	29	2.3	2.4	2.4
8	.....	2.6	2.3	19	2.3	2.5	2.4	30	2.4	2.4	2.4
9	.....	2.5	2.3	20	2.5	2.5	2.4	31	2.4	.....	2.4
10	.....	2.5	2.3	21	2.6	2.9	2.4				
11	.....	2.4	2.3	22	2.6	2.9	2.4				

WEST FORK CARSON RIVER AT WOODFORDS, CALIFORNIA.

This stream rises on the eastern slope of the Sierra Nevada in California, immediately to the southeast of the source of Truckee River, and flowing in a general northeast direction crosses the State line into Nevada and joins the East Fork near Genoa, in Carson Valley. The drainage area is mapped on the Markleeville atlas sheet of the United States Geological Survey. The gaging station, established by L. H. Taylor on October 18, 1900, is about three-fourths of a mile above the post-office at Woodfords, near the point where measurements were made in 1890, 1891, and 1892, the results of which are given in the Thirteenth Annual Report, Part III, page 96. The gage at present in use is a vertical timber, but it is only temporary, the equipment of the station being incomplete. The channel at the station is straight, the banks are high and rocky, and the bed is of rock and gravel and not likely to shift. Measurements are made from a car suspended on a steel cable across the stream.

Daily gage height, in feet, of West Fork Carson River at Woodfords, California, for 1900.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		2.55	2.55	12		2.45	2.50	23	2.40	2.35	2.65
2		2.50	2.50	13		2.40	2.45	24	2.40	2.45	2.70
3		2.45	2.50	14		2.40	2.50	25	2.30	2.60	2.67
4		2.40	2.45	15		2.45	2.48	26	2.30	2.50	2.65
5		2.40	2.40	16		2.50	2.35	27	2.20	2.50	2.70
6		2.40	2.50	17		2.40	2.40	28	2.20	2.45	2.65
7		2.50	2.35	18	2.40	2.45	2.35	29	2.35	2.50	2.60
8		2.60	2.40	19	2.50	2.50	2.40	30	2.40	2.55	2.60
9		2.60	2.50	20	2.70	2.50	2.50	31	2.50		2.60
10		2.55	2.45	21	2.70	2.55	2.70				
11		2.50	2.50	22	2.50	2.40	2.60				

CARSON RIVER NEAR EMPIRE, NEVADA.

This river has its source on the slopes of the Sierra Nevada in eastern California, and flows northward into the State of Nevada. At Empire, 3 miles east of Carson, after having traversed the upper Carson Valley, it turns to the northeast and enters a deep canyon, through which it flows for several miles, emerging into a second smaller valley a short distance above the town of Dayton. After leaving this valley it passes through two other shorter canyons and through one rather large valley before entering Lower Carson Valley, or Carson Sink Valley, as it is also known, and discharging its waters into the Carson Sink. The drainage area is mapped on the Dardanelles, Markleeville, Carson, and Wabuska atlas sheets of the United States Geological Survey. On October 21, 1900, a gaging station was established about 2 miles below the town of Empire and about three-fourths of a mile below the point where measurements were made by Mr. Taylor in 1895, the results of which are given in Bulletin of United States Geological Survey No. 140 (Report of progress of the Division of Hydrography of the United States Geological Survey for the calendar year 1895). The gage, a temporary one, is vertical, driven into the stream bed, and spiked to a timber set firmly in the left bank. The bench mark is on a stone wall 10 feet from the gage and at an elevation of 7.5 feet above gage datum. The channel is straight, the banks are rather high, and the bed is composed of cobbles and gravel and is not likely to shift or corrode.

Daily gage height, in feet, of Carson River near Empire, Nevada, for 1900.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		2.40	2.55	12		2.50	2.60	22	2.60	3.05	2.70
2		2.40	2.50	13		2.50	2.60	23	2.50	2.90	2.60
3		2.40	2.50	14		2.50	2.55	24	2.50	2.70	2.60
4		2.40	2.50	15		2.50	2.50	25	2.50	2.60	2.60
5		2.45	2.50	16		2.50	2.50	26	2.50	2.60	2.60
6		2.40	2.50	17		2.50	2.60	27	2.50	2.60	2.60
7		2.40	2.50	18		2.50	2.60	28	2.50	2.60	2.55
8		2.50	2.50	19		2.50	2.60	29	2.40	2.60	2.55
9		2.65	2.50	20		2.50	2.60	30	2.40	2.60	2.40
10		2.50	2.50	21	2.60	2.65	2.60	31	2.40		2.40
11		2.50	2.60								

TRUCKEE RIVER AT TAHOE, CALIFORNIA.

Truckee River, the natural outlet of Lake Tahoe, leaves the lake at the city of Tahoe. About 500 feet from the lake there is a timber dam across the river, which has been maintained for more than twenty years, for the purpose of controlling the discharge from the lake. During the early part of the year 1900 the gates in this dam were kept closed, not being opened until June 17, when a gage was placed in the stream for the purpose of recording the height of the water in the river. The gage is a vertical timber driven into the stream bed at the left bank about 300 feet below the dam, and is spiked to the root of a tree growing on the bank. The bench mark is cut in the side of the tree and is 4 feet above gage datum. The measurements are made from a cable and suspended car about one-fourth mile below the gage, which was placed as near the city of Tahoe as possible for the convenience of the observer. At the point of measurement the right bank is low and is subject to overflow at very high stages of the stream, but the left bank is rather high. The channel is nearly straight for a short distance above and below the station, and the bed of the river, which is of gravel and coarse sand, is smooth and stable. The purpose of the station is to ascertain the actual outflow from Lake Tahoe, with a view to determining its real value as a storage reservoir. The following measurements were made during 1900:

Discharge measurements of Truckee River at Tahoe, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
June 18	0.75	92	October 23	0.40	52
June 30	1.45	240	Do	.95	120
July 12	1.60	277	Do	1.15	158
September 7	1.40	225			

Daily gage height, in feet, of Truckee River at Tahoe, California, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	(a)	1.55	1.35	1.20	1.10	(a)
2	.....	1.45	1.55	1.35	1.15	1.10	0.80
3	.....	1.45	1.55	1.30	1.15	1.10	.80
4	.....	(a)	1.50	1.30	1.15	1.10	.60
5	.....	1.45	1.55	1.30	1.20	1.10	.60
6	.....	1.45	1.50	1.30	1.20	1.10	.80
7	.....	1.45	1.50	1.40	1.15	1.10	.80
8	.....	(a)	1.50	1.35	1.15	1.10	.80
9	.....	1.45	1.45	1.35	1.15	1.10	.80
10	.....	1.45	1.45	1.35	1.10	1.10	.80
11	.....	1.45	1.45	1.30	1.10	1.10	.80
12	.....	1.45	1.45	1.30	1.10	1.10	.80
13	.....	1.45	1.45	1.30	1.10	1.10	.80
14	.....	1.45	1.45	1.30	1.10	1.10	.80
15	.....	.75	1.45	1.30	1.10	1.10	.80
16	.....	1.50	1.45	1.25	1.10	1.10	.80
17	0.75	1.45	1.45	1.20	1.10	1.10	.60
18	.75	1.50	1.45	1.35	1.10	1.10	.60
19	.75	1.45	1.40	1.30	1.10	1.10	.60
20	.75	1.50	1.45	1.35	1.10	1.10	.60
21	(a)	1.50	1.40	1.30	1.10	1.20	.60
22	.80	1.50	1.40	1.30	1.10	1.30	.60
23	(a)	1.50	1.40	1.20	1.10	.90	.60
24	(a)	1.50	1.40	1.20	1.10	.90	.60
25	1.10	1.50	1.40	1.20	1.10	.90	.60
26	(a)	1.50	1.40	1.20	1.10	.90	.60
27	1.45	1.45	1.40	1.20	1.10	.90	.60
28	1.45	1.45	1.40	1.20	1.10	(a)	.60
29	1.45	1.50	1.40	1.20	1.10	(a)	.60
30	1.45	1.50	1.35	1.20	1.10	(a)	.60
31	.....	1.55	1.35	.....	1.10	.....	.60

a All gates closed; no water flowing from lake.

TRUCKEE RIVER AT NEVADA-CALIFORNIA STATE LINE.

This station is described in Water-Supply Paper No. 38, page 331. During 1900 the following measurements were made by L. H. Taylor:

Discharge measurements of Truckee River at Nevada-California State line.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 10	2.90	753	July 1	2.50	534
May 15	4.10	1,493	July 14	2.50	551
May 22	4.30	1,629	September 6	2.30	447
June 1	3.70	1,112	October 2	1.90	318
June 15	3.20	901			

Daily gage height, in feet, of Truckee River at Nevada-California State line, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	1.90	2.00	3.40	4.00	3.70	2.50	2.10	2.40	2.30	2.30	1.60
2	2.00	1.90	1.90	3.20	4.00	3.70	2.50	2.10	2.00	2.00	2.00	1.60
3	2.80	1.90	1.90	3.00	3.80	3.60	2.50	2.10	1.80	2.10	2.00	1.60
4	3.20	1.90	2.00	3.00	4.00	3.60	2.40	2.10	2.40	2.10	2.40	1.80
5	2.80	1.90	2.00	3.20	4.30	3.50	2.40	2.10	2.20	2.20	2.40	1.80
6	2.70	1.80	2.00	3.20	4.00	3.70	2.40	2.10	2.30	2.20	2.40	1.80
7	2.30	1.80	2.30	3.20	4.10	3.70	2.40	2.10	2.20	2.30	2.70	2.00
8	2.10	1.80	2.40	3.20	4.30	4.00	2.40	2.10	2.10	2.20	2.50	2.20
9	2.00	1.80	2.60	3.20	4.40	4.00	2.40	2.10	2.10	2.20	2.40	2.20
10	2.00	1.80	2.60	3.20	4.60	3.70	2.40	2.10	2.10	2.10	2.40	2.20
11	2.00	1.80	2.60	3.10	4.60	3.70	2.40	2.10	2.10	2.00	2.40	2.20
12	2.00	1.90	2.90	3.00	4.00	3.60	2.40	2.10	2.20	2.00	2.40	2.20
13	2.10	2.00	3.00	2.90	3.80	4.00	2.40	2.10	2.20	2.00	2.40	2.20
14	2.30	2.00	3.40	2.90	3.80	3.70	2.40	2.10	2.30	2.00	2.30	2.00
15	2.20	2.00	3.60	2.90	4.30	3.20	2.40	2.10	2.30	2.00	2.20	2.00
16	2.20	2.00	3.40	2.90	4.40	3.20	2.40	2.10	2.30	2.30	2.20	2.00
17	2.20	2.00	3.40	3.00	4.40	3.20	2.30	2.10	2.30	1.70	2.20	2.00
18	2.20	2.00	3.20	3.00	4.50	3.20	2.20	2.10	2.30	2.00	2.20	2.20
19	2.20	2.00	3.40	3.40	4.50	3.10	2.20	2.20	2.30	2.30	2.20	2.40
20	2.20	2.10	3.40	3.60	4.60	3.00	2.30	2.20	2.30	3.20	2.20	3.60
21	2.00	2.10	3.60	3.60	4.40	3.00	2.30	2.20	2.10	3.10	2.50	3.00
22	2.00	2.10	3.50	3.50	4.50	2.90	2.30	2.40	2.00	3.00	3.20	3.00
23	1.90	2.10	3.40	3.10	4.40	3.00	2.30	2.40	2.00	2.90	3.00	2.90
24	1.90	2.10	3.40	3.00	4.00	2.00	2.30	2.40	1.60	2.90	2.80	2.00
25	1.90	2.10	3.40	3.30	4.00	2.70	2.30	2.40	1.60	2.80	2.50	2.20
26	1.90	2.10	3.60	3.50	4.00	2.70	2.20	2.00	1.60	2.80	2.50	2.20
27	1.90	2.10	3.60	3.10	3.80	2.60	2.20	2.20	2.00	2.70	2.30	2.00
28	1.90	2.10	3.40	3.00	3.80	2.60	2.20	2.20	1.70	2.70	2.00	2.00
29	1.90	.....	3.40	3.40	3.80	2.60	2.20	2.40	1.90	2.40	2.00	2.00
30	1.90	.....	3.40	4.00	3.70	2.60	2.20	2.40	2.10	2.00	2.00	2.20
31	1.90	.....	3.40	.....	3.70	.....	2.20	2.40	.....	2.40	.....	2.00

TRUCKEE RIVER AT VISTA, NEVADA.

This station is described in Water-Supply Paper No. 38, page 331. During 1900 the following measurements were made by L. H. Taylor:

Discharge measurements of Truckee River at Vista, Nevada.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
April 25	3.30	757	June 28	2.70	372
May 14	3.80	989	July 2	2.20	207
May 23	4.30	1,326	July 10	2.05	138
June 9	3.80	967	July 24	2.00	99
June 14	4.10	1,150	August 22	2.30	198
June 19	2.90	471	September 28	2.25	226

Daily gage height, in feet, of Truckee River at Vista, Nevada, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.85	2.70	2.75	3.60	4.50	3.40	2.45	1.85	2.10	2.15	2.80	2.90
2	2.80	2.70	2.80	3.70	4.50	3.60	2.35	1.85	2.00	2.35	2.85	3.00
3	4.15	2.70	2.80	3.60	4.60	3.50	2.20	1.90	2.10	2.40	2.90	2.85
4	3.95	2.60	2.80	3.40	4.30	4.05	2.20	1.85	2.40	2.50	2.50	2.80
5	3.45	2.60	2.80	3.40	4.00	3.60	2.20	1.90	2.40	2.75	2.55	2.90
6	3.20	2.65	2.90	3.30	4.50	3.60	2.20	1.80	2.40	2.75	2.60	2.90
7	3.15	2.70	3.00	3.30	4.55	3.60	2.15	1.85	2.25	2.70	2.65	2.70
8	3.10	2.70	3.15	3.30	4.60	4.20	2.10	1.85	2.20	2.70	2.70	2.85
9	2.50	2.60	3.35	3.20	4.45	3.75	2.10	1.85	2.20	2.70	2.75	2.85
10	2.80	2.60	3.40	3.10	4.60	3.60	2.00	1.90	2.15	2.40	2.80	2.80
11	2.90	2.70	3.45	3.10	4.60	3.55	2.00	1.90	2.10	2.50	2.80	2.80
12	2.90	2.70	3.50	3.10	4.60	3.55	2.00	1.90	2.20	2.55	2.80	2.80
13	3.00	2.75	3.65	3.00	3.80	3.60	1.90	1.90	2.30	2.60	2.80	2.80
14	2.90	2.75	3.80	2.90	3.75	4.00	1.90	2.00	2.15	2.50	2.75	2.75
15	2.95	2.80	3.80	2.90	4.15	3.50	1.95	2.05	2.20	2.50	2.80	2.80
16	2.90	2.85	3.80	2.90	4.55	3.30	1.90	2.10	2.20	2.55	3.00	2.80
17	2.85	2.90	3.90	2.80	4.40	3.10	2.00	2.05	2.30	2.60	2.90	2.80
18	2.80	2.60	3.90	2.80	4.25	3.10	1.90	1.90	2.20	2.75	2.90	2.75
19	2.80	2.60	3.90	2.80	4.40	2.90	1.80	2.20	2.20	2.70	2.85	2.85
20	2.80	2.60	3.90	2.90	4.55	3.00	1.75	2.10	2.35	4.00	2.90	2.95
21	2.80	2.70	3.95	4.20	4.35	2.85	1.75	2.10	2.30	3.00	4.00	4.25
22	2.85	2.70	3.95	4.20	4.35	2.75	1.75	2.25	2.20	3.00	4.30	4.00
23	2.80	2.75	3.90	3.50	4.25	2.70	1.80	2.30	2.20	2.95	3.90	3.30
24	2.70	2.75	3.80	3.40	4.00	2.70	2.10	2.30	2.10	2.85	3.30	3.00
25	2.70	2.70	3.80	3.40	3.85	2.70	1.90	2.40	2.10	2.80	3.10	2.80
26	2.70	2.70	3.80	3.40	3.80	2.65	1.95	2.20	2.10	2.75	3.25	3.05
27	2.60	2.70	3.70	3.50	3.90	2.65	1.90	2.20	2.10	2.75	3.00	2.90
28	2.60	2.75	3.70	3.60	3.75	2.65	1.90	2.10	2.30	2.60	2.90	2.70
29	2.60	.....	3.70	3.50	3.80	2.35	1.80	2.00	2.20	2.70	2.80	2.85
30	2.70	.....	3.70	4.00	3.80	2.55	1.80	2.10	2.20	2.75	2.80	2.95
31	2.65	.....	3.60	.....	3.50	.....	1.85	2.10	.....	2.75	.....	3.20

MISCELLANEOUS DISCHARGE MEASUREMENTS IN TRUCKEE BASIN.

During the year discharge measurements were made of a number of streams in this basin, as recorded in the following table:

Miscellaneous discharge measurements in Truckee Basin.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
May 5	Ward Creek	Sunnyside, Cal	L. H. Taylor	147
June 16	Deer Creek	Near Truckee River, Cal	C. V. Taylor	25
June 5	Squaw Creek	do	do	81
June 16	do	do	do	46
September 14	do	do	do	3
May 16	Donner Creek	Near Donner Lake, Cal	L. H. Taylor	128
May 29	do	do	C. V. Taylor	73
July 13	do	do	do	1
August 20	do	do	do	69
September 13	do	do	do	19
Do	Cold Creek	At Cold Creek Canyon, Cal	do	1
May 21	Donner Creek	Truckee, Cal	do	324
June 3	do	do	do	127
July 13	do	do	do	15
June 3	Truckee River	do	do	364
June 12	do	do	do	264
May 21	Martis Creek	Martis, Cal	do	25
June 4	do	do	do	18
September 14	do	do	do	9
June 4	Prosser Creek	Two miles above railroad	do	145
September 9	do	Prosser, Cal	do	10
July 27	do	do	do	25
September 15	Little Truckee River.	Boca, Cal	do	27
August 16	do	do	do	9
September 15	Juniper Creek	Burkhalter, Cal	do	1
July 28	Jo Gray Creek	Iceland, Cal	do	20
September 15	do	do	do	12
July 25	Alder Creek	Floriston, Cal	do	13
September 10	do	do	do	10
July 26	Dog Creek	Verdi, Nev	do	0.4
September 10	do	do	do	1
June 7	Hunter Creek	Mayberry, Nev	do	41
September 12	do	do	do	6

STEAMBOAT CREEK AT STEAMBOAT SPRINGS, NEVADA.

This stream is the outlet of the Washoe Lake Basin, lying on the eastern slope of the Tahoe range of mountains. The total drainage area above the station at Steamboat Springs is 123 square miles. The station was established May 31, 1900, for the purpose of ascertaining the volume of water entering Reno Valley through this stream. It is at a footbridge across the creek about 200 yards east of the Virginia and Truckee Railroad station at Steamboat, at the point where the stream enters Reno Valley, on the main Truckee River. The gage is a vertical timber driven into a seam in the rock of the stream bed and spiked to the footbridge which spans the creek, from which measurements are made. The channel is straight for a short distance above and below the station, and the banks are high and not subject to overflow. The stream bed is of limestone and is perfectly stable. The bench mark is on a post driven in the ground on the right bank of the stream at the end of the bridge, and is at an elevation of 5 feet above gage datum. The following measurements were made during 1900:

May 31: Gage height, 1.06 feet; discharge, 23 second-feet.
June 9: Gage height, 1.30 feet; discharge, 34 second-feet.
July 2: Gage height, 0.75 foot; discharge, 12 second-feet.
July 11: Gage height, 0.55 foot; discharge, 6 second-feet.
August 21: Gage height, 0.35 foot; discharge, 3 second-feet.
September 16: Gage height, 0.35 foot; discharge, 3 second-feet.

Daily gage height, in feet, of Steamboat Creek at Steamboat Springs, Nevada, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.05	0.60	0.40	0.30	0.30	0.60	0.60
2	.....	1.05	.60	.40	.30	.35	.60	.60
3	.....	1.02	.60	.40	.30	.40	.60	.60
4	.....	1.08	.60	.40	.30	.40	.65	.60
5	.....	1.30	.60	.40	.30	.35	.65	.60
6	.....	1.15	.70	.40	.30	.35	.65	.60
7	.....	1.50	.70	.40	.30	.35	.75	.60
8	.....	1.50	.70	.30	.30	.35	.70	.60
9	.....	1.10	.80	.30	.30	.30	.65	.60
10	.....	1.40	.70	.40	.30	.35	.65	.60
11	.....	1.40	.55	.40	.30	.35	.65	.60
12	.....	1.45	.55	.30	.30	.35	.60	.60
13	.....	1.60	.50	.35	.40	.40	.60	.60
14	.....	1.60	.55	.40	.30	.40	.60	.60
15	.....	1.55	.55	.40	.35	.40	.60	.60
16	.....	1.50	.60	.35	.40	.40	.70	.80
17	.....	1.30	.60	.30	.35	.40	.65	.65
18	.....	1.10	.55	.30	.35	.45	.65	.60
19	.....	1.00	.55	.30	.35	.80	.65	.60
20	.....	.90	.50	.30	.30	.60	.70	.60
21	.....	.90	.50	.30	.30	.50	2.00	.60
22	.....	.80	.50	.30	.35	.50	.70	.60
23	.....	.60	.50	.30	.40	.50	.65	.60
24	.....	.50	.45	.30	.40	.60	.60	.60
25	.....	.50	.45	.30	.40	.60	.60	.60
26	.....	.40	.45	.30	.25	.60	.60	.60
27	.....	.40	.50	.32	.30	.60	.60	.60
28	.....	.40	.50	.30	.30	.60	.60	.60
29	.....	.50	.50	.30	.35	.60	.60	.60
30	1.06	.55	.45	.32	.30	.60	.60	.60
31	1.06	.....	.45	.35	.....	.60	.....	.60

WILLOW CREEK NEAR STANDISH, CALIFORNIA.

This stream, which is tributary to Susan River about 12 miles east of the town of Susanville, has its source among the outlying spurs of the Sierra Nevada to the northeast of the watershed of that river. It is more regular in its discharge than is Susan River, and although its waters are employed for the irrigation of considerable land in Willow Creek Valley, on its upper course, during the latter part of the irrigating season it is the main reliance for the water supply for the lands bordering Honey Lake on the northwest. The gaging station, established by L. H. Taylor on June 4, 1900, is at the highway bridge about 4 miles west of north from the post-office at Standish and about 1½ miles north of Susan River. As in the case of the latter stream, a temporary gage is being used. Measurements are made from the bridge. The channel at the station is straight for a short distance. The left bank is high, but the right bank is low and is subject to overflow at extreme high water, which does not, however, occur oftener than once in five or six years. The stream bed is sandy and shifts some.

Ravenscroft ditch diverts water from the creek near the station. During 1900 its discharge was measured three times, as follows: June 4, discharge, 1.5 second-feet; July 30, discharge, 1 second-foot; October 10, discharge, 0.3 second-foot.

During the year the following discharge measurements were made at the main station by L. H. Taylor:

June 4: Gage height, 2.60 feet; discharge, 16 second-feet.
July 30: Gage height, 2.85 feet; discharge, 26 second-feet.
October 10: Gage height, 2.80 feet; discharge, 20 second-feet.

Daily gage height, in feet, of Willow Creek near Standish, California, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.70	3.10	2.90	3.10	3.40	3.70
2	.....	2.70	3.20	2.90	3.10	3.40	3.70
3	.....	3.00	3.10	2.90	3.10	3.40	3.70
4	2.60	2.80	3.10	2.90	3.00	3.50	3.70
5	2.60	2.80	3.10	2.90	2.90	3.50	3.70
6	2.60	2.65	3.10	2.90	2.75	3.50	3.70
7	2.60	2.65	3.10	2.90	3.10	3.60	3.70
8	2.60	2.63	3.00	2.90	3.00	3.60	3.70
9	2.60	2.70	3.00	2.90	2.80	3.60	3.70
10	2.60	2.70	2.95	2.90	3.40	3.60	3.70
11	2.65	2.70	2.95	2.95	3.90	3.60	3.70
12	2.65	2.70	2.95	2.95	3.30	3.60	3.70
13	2.65	2.70	2.95	3.00	3.20	3.60	3.75
14	2.65	2.70	2.95	3.00	3.30	3.70	4.90
15	2.80	2.70	2.95	3.00	3.30	3.70	5.50
16	2.80	2.70	2.90	3.00	3.30	3.80	5.50
17	2.80	2.70	2.90	3.00	3.30	3.80	5.50
18	2.80	2.70	2.80	3.00	3.30	3.80	5.50
19	2.70	2.70	2.90	3.00	3.30	3.80	8.00
20	2.70	2.70	2.90	3.00	3.30	3.85	8.00
21	2.70	2.70	2.90	3.00	3.30	3.95	8.60
22	2.70	2.70	2.90	3.00	3.30	4.00	8.50
23	2.70	2.70	2.90	3.00	3.30	4.10	8.20
24	2.70	2.70	2.90	2.90	3.40	4.10	7.90
25	2.70	2.80	3.00	3.00	3.40	4.20	7.60
26	2.70	2.80	2.80	3.00	3.40	4.20	7.50
27	2.70	2.90	2.80	3.00	3.40	4.10	7.20
28	2.70	3.00	2.80	3.10	3.40	4.00	6.70
29	2.70	3.10	2.80	3.10	3.40	3.90	6.50
30	2.70	3.10	2.80	3.10	3.40	3.80	5.80
31	.....	3.10	2.80	.....	3.40	.....	4.60

SUSAN RIVER NEAR SUSANVILLE, CALIFORNIA.

This river has its source in the Sierra Nevada in northeastern California, and flowing eastward discharges into Honey Lake—one of the land-locked lakes of the Great Basin—of which it is the principal feeder. A considerable area of land is irrigated from the waters of the river below the gaging station, and during the last ten or twelve years several projects have been started for irrigating other very extensive areas by the storage of its waters both above and below the town of Susanville. The gaging station is about three-fourths of a mile southwest of the town, at the electric-light plant. It was established June 3, 1900, by L. H. Taylor, a temporary gage being placed in the right bank of the river. The station is designed to be equipped with a cable and suspended car from which to make measurements of the discharge, but these and the permanent gage have not yet been put into place. The channel is straight for a distance above and below the station, and the banks are high. The stream bed is of gravel and cobbles, and is rather stable.

A short distance above the station a small irrigating ditch, known as the Masten ditch, is taken out on the right bank of the stream. Near its head is a flume in which a gage has been placed and measurements are made. On July, 5, 1900, this ditch was discharging 7 second-feet. During 1900 two measurements were made of the discharge of the river at Susanville, under the direction of L. H. Taylor, as follows:

June 3: Gage height, 3.20 feet; discharge, 40 second-feet.
July 5: Gage height, 2.60 feet; discharge, 8 second-feet.

Daily gage height, in feet, of Susan River near Susanville, California, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.70	2.45	2.40	2.40	2.65	3.00
2	.....	2.65	2.40	2.40	2.40	2.65	3.00
3	.....	2.65	2.40	2.40	2.70	2.65	3.00
4	3.20	2.60	2.40	2.40	2.60	2.65	2.95
5	3.15	2.60	2.35	2.40	2.60	2.65	2.95
6	3.10	2.60	2.35	2.40	2.60	2.60	2.90
7	3.10	2.55	2.40	2.40	2.60	2.70	2.90
8	3.05	2.55	2.45	2.40	2.65	2.70	2.90
9	3.00	2.55	2.40	2.40	2.65	2.70	2.90
10	3.00	2.50	2.40	2.40	2.50	2.70	2.90
11	3.00	2.45	2.40	2.40	2.50	2.70	2.90
12	2.95	2.40	2.40	2.40	2.50	2.70	2.90
13	3.10	2.40	2.40	2.35	2.50	2.70	2.90
14	3.10	2.40	2.40	2.35	2.55	2.70	2.90
15	3.10	2.40	2.40	2.35	2.60	2.70	2.90
16	3.15	2.40	2.40	2.35	2.60	2.90	2.90
17	3.10	2.40	2.45	2.35	2.60	2.90	3.00
18	3.05	2.40	2.45	2.35	2.60	2.90	3.00
19	3.05	2.40	2.45	2.35	2.90	2.90	3.10
20	3.05	2.40	2.40	2.35	3.10	2.90	4.80
21	3.05	2.40	2.40	2.35	2.90	4.60	4.40
22	3.00	2.40	2.40	2.35	2.80	3.80	3.80
23	3.00	2.40	2.40	2.35	2.80	3.50	3.50
24	3.00	2.45	2.40	2.35	2.80	3.30	3.40
25	2.95	2.45	2.35	2.40	2.75	3.80	3.30
26	2.90	2.45	2.40	2.40	2.60	3.40	3.20
27	2.75	2.45	2.40	2.40	2.60	3.30	3.20
28	2.80	2.45	2.45	2.40	2.65	3.30	3.20
29	2.70	2.45	2.40	2.40	2.65	3.20	3.10
30	2.60	2.45	2.40	2.40	2.70	3.10	3.10
31	.....	2.45	2.40	.....	2.65	.....	3.10

Daily gage height, in feet, of Masten ditch near Susanville, California, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.75	0.50	0.55	0.75	0.60	0.60
2	.....	.75	.50	.50	.80	.60	.50
3	.....	.75	.50	.60	1.00	.60	.50
4	.....	.75	.50	.60	.85	.60	.45
5	.....	.75	.45	.60	.90	.60	.45
6	.....	.70	.55	.60	.85	.60	.40
7	.....	.65	.55	.60	.80	.55	.40
8	.....	.60	.50	.65	.75	.55	.40
9	.....	.60	.50	.65	.75	.55	.40
10	.....	.65	.50	.65	.70	.55	.40
11	.....	.65	.50	.70	.70	.55	.40
12	.....	.65	.50	.70	.70	.55	.40
13	.....	.65	.50	.80	.70	.50	.40
14	.....	.65	.50	.80	.65	.50	.40
15	.....	.65	.50	.75	.60	.50	.40
16	.....	.65	.50	.75	.60	.60	.40
17	.....	.65	.45	.75	.60	.60	.50
18	.....	.65	.45	.75	.60	.60	.50
19	.....	.65	.45	.75	.80	.60	.60
20	.....	.65	.60	.75	.90	.60	.90
21	.....	.65	.60	.75	.70	.90	.90
22	.....	.60	.55	.75	.00	.70	.80
23	.....	.60	.55	.80	.00	.70	.60
24	.....	.55	.55	.80	.00	.60	.60
25	0.30	.55	.55	.85	.00	.70	.60
26	.65	.55	.50	.85	.70	.60	.60
27	.85	.55	.50	.75	.70	.60	.40
28	.85	.55	.50	.75	.65	.60	.00
29	.85	.55	.50	.75	.65	.60	.00
30	.80	.55	.50	.75	.65	.60	.....
31	.....	.55	.55	.....	.60	.....	.....

BEAR RIVER AT BATTLECREEK, IDAHO.

This station, established October 11, 1889, is about 10 miles north of the Utah-Idaho boundary line. It is described in Water-Supply Paper No. 38, page 332. There are two bench marks to which the gage is referred; the first is a nail in the bridge floor beam close to the gage, and the second is three nails in the east side of the north post which supports the station cable. Both of these bench marks are 11.118 feet above the gage datum. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 315; for 1897, Nineteenth Annual Report, Part IV, page 432; for 1898, Twentieth Annual Report, Part IV, page 459; for 1899, Twenty-first Annual Report, Part IV, page 394. During 1900 the following measurements of discharge were made by George L. Swendsen:

Discharge measurements of Bear River at Battlecreek, Idaho.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
February 12	1.75	958	August 31	1.40	487
March 26	2.95	1,880	September 26	1.60	604
April 23	2.88	1,585	October 20	1.70	627
May 28	3.50	2,232	November 5	1.75	662
June 26	2.15	973	December 22	1.85	664
July 27	1.57	543			

Daily gage height, in feet, of Bear River at Battlecreek, Idaho, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.00	1.85	2.70	3.35	3.40	1.95	1.50	1.35	1.60	1.75	1.80
2	1.90	1.90	1.90	2.70	3.40	3.40	1.90	1.50	1.35	1.60	1.75	1.80
3	1.90	1.90	1.95	2.80	3.40	3.45	1.90	1.50	1.35	1.60	1.75	1.80
4	2.10	1.90	1.95	2.80	3.45	3.45	1.85	1.50	1.35	1.60	1.75	1.80
5	2.10	1.80	2.05	2.80	3.45	3.40	1.85	1.50	1.35	1.60	1.75	1.80
6	2.00	1.80	2.05	2.80	3.50	3.40	1.80	1.50	1.35	1.60	1.75	1.80
7	2.00	1.70	2.05	2.83	3.50	3.35	1.80	1.50	1.35	1.60	1.75	1.80
8	2.00	1.60	2.23	2.85	3.50	3.35	1.80	1.50	1.35	1.60	1.75	1.80
9	2.00	1.35	2.23	2.90	3.50	3.30	1.80	1.48	1.35	1.60	1.75	1.80
10	2.00	1.70	2.35	2.90	3.50	3.20	1.80	1.45	1.35	1.60	1.75	1.80
11	1.90	2.45	2.48	2.90	3.55	3.10	1.75	1.45	1.35	1.60	1.75	1.80
12	1.95	1.80	2.58	2.90	3.70	3.00	1.75	1.45	1.35	1.60	1.75	1.80
13	2.10	1.73	2.60	2.90	3.70	2.90	1.70	1.45	1.35	1.60	1.75	1.80
14	2.20	1.75	2.75	2.90	3.75	2.80	1.70	1.45	1.35	1.60	1.75	1.75
15	2.23	1.83	2.83	2.85	3.70	2.75	1.70	1.40	1.35	1.60	1.75	1.75
16	2.00	1.75	2.95	2.85	3.60	2.75	1.70	1.40	1.35	1.60	1.75	1.75
17	2.15	2.00	3.08	2.78	3.60	2.60	1.70	1.35	1.35	1.60	1.75	1.75
18	2.10	1.85	3.28	2.70	3.55	2.55	1.70	1.35	1.35	1.60	1.75	1.75
19	2.10	1.78	3.35	2.70	3.55	2.50	1.70	1.35	1.40	1.60	1.75	1.75
20	2.00	1.88	3.50	2.70	3.50	2.50	1.70	1.35	1.40	1.70	1.75	1.75
21	2.00	1.88	3.65	2.80	3.43	2.43	1.70	1.35	1.40	1.70	1.80	1.80
22	2.00	1.90	3.35	2.95	3.35	2.40	1.70	1.35	1.40	1.70	1.85	1.85
23	1.90	1.80	3.20	2.90	3.35	2.35	1.75	1.35	1.50	1.70	1.80	1.55
24	1.90	1.80	3.05	2.90	3.35	2.30	1.75	1.35	1.50	1.80	1.90	1.55
25	1.80	1.80	2.95	2.90	3.38	2.25	1.70	1.35	1.60	1.80	1.90	1.55
26	2.10	1.85	3.00	3.00	3.45	2.15	1.70	1.35	1.60	1.80	1.90	1.55
27	2.10	1.80	3.00	3.13	3.50	2.00	1.60	1.35	1.60	1.80	1.80	1.55
28	2.00	1.85	2.95	3.28	3.45	2.00	1.60	1.35	1.60	1.80	1.80	1.55
29	1.90	.....	2.85	3.30	3.45	2.00	1.55	1.35	1.60	1.75	1.80	1.55
30	1.80	.....	2.80	3.30	3.40	1.95	1.50	1.35	1.60	1.75	1.80	1.55
31	1.90	.....	2.75	.....	3.40	.....	1.50	1.35	.....	1.75	.....	1.55

CUB RIVER AT FRANKLIN, IDAHO.

Cub River rises in the southern part of Idaho, and flowing in a southwesterly direction into Utah discharges its waters into Bear River. Six canals are supplied from this stream, the total area irrigated being about 7,000 acres, part of which is in Idaho and part in Utah. During the irrigation season the supply of water in the river is considerably below the needs of the lands, but in the early spring the discharge exceeds 500 second-feet, and already some consideration has been given to the storage of this surplus by the construction of a reservoir at a very favorable site near the headwaters of the river. The gaging station, established July 23, 1900, is a short distance above the head gates of the Lewiston canal. Daily readings are made on a vertical gage graduated to feet and tenths. The bench mark is a cross cut in the top of a cedar stump 95 feet west of the gage, and is 6.95 feet above the gage datum. During 1900 the following measurements of discharge were made by George L. Swendsen:

May 29: Gage height, —— feet; discharge, 462 second-feet.
July 23: Gage height, 2.20 feet; discharge, 74 second-feet.
August 30: Gage height, 1.80 feet; discharge, 67 second-feet.
September 22: Gage height, 1.65 feet; discharge, 55 second-feet.
October 27: Gage height, 1.82 feet; discharge, 61 second-feet.
November 19: Gage height, 1.41 feet; discharge, 43 second-feet.
December 24: Gage height, 1.50 feet; discharge, 46 second-feet.

Daily gage height, in feet, of Cub River at Franklin, Idaho, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.2	1.8	1.9	1.7	1.2	17	.....	1.9	1.9	1.8	1.3	1.2
2	.....	2.2	1.8	1.9	1.7	1.4	18	.....	1.9	1.8	1.8	1.3	1.2
3	.....	2.1	1.8	1.8	1.7	1.4	19	.....	1.9	1.7	1.8	1.3	1.2
4	.....	2.1	1.8	1.8	1.6	1.6	20	.....	1.9	1.8	1.7	1.3	1.2
5	.....	2.1	1.8	1.8	1.6	1.6	21	.....	1.9	1.8	1.6	1.3	1.2
6	.....	2.1	1.8	1.8	1.7	1.5	22	.....	1.9	1.8	1.6	1.3	1.2
7	.....	2.1	1.8	1.7	1.7	1.5	23	2.2	1.8	1.8	1.7	1.2	1.4
8	.....	2.1	1.8	1.7	1.7	1.7	24	2.2	1.8	1.8	1.6	1.3	1.5
9	.....	2.1	1.8	1.8	1.8	1.8	25	2.2	1.8	1.8	1.6	1.4	1.5
10	.....	2.0	1.8	1.7	1.8	1.7	26	2.2	1.8	1.8	1.6	1.4	1.4
11	.....	2.0	1.8	1.7	1.5	1.6	27	2.2	1.8	1.8	1.8	1.4	1.3
12	.....	2.0	1.8	1.8	1.3	1.5	28	2.2	1.8	1.8	1.8	1.3	1.2
13	.....	2.0	1.8	1.8	1.4	1.4	29	2.2	1.8	1.8	1.7	1.2	1.2
14	.....	2.0	1.8	1.7	1.4	1.4	30	2.2	1.8	1.9	1.7	1.2	1.3
15	.....	1.9	1.8	1.6	1.3	1.3	31	2.2	1.8	.....	1.7	.....	1.4
16	.....	1.9	1.8	1.8	1.3	1.3							

LOGAN RIVER NEAR LOGAN, UTAH.

This station, established June 1, 1896, is in the river canyon about 2 miles east of Logan. It is described in Water-Supply Paper No. 38, page 334. During the low-water season the entire supply of the river is used for irrigation. Within the last two years it has become very prominent as a source of water power, and there is in course of construction a very large plant intended to utilize the low-water supply. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 316; for 1898, Nineteenth Annual Report, Part IV, page 434; for 1898, Twentieth Annual Report, Part IV, page 462; for 1899, Twenty-first Annual Report, Part IV, page 397. During 1900 the following discharge measurements were made by George L. Swendsen:

Discharge measurements of Logan River near Logan, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
January 8	2.71	272	May 31	4.00	849
February 16	2.55	243	June 30	3.32	449
March 19	2.65	222	July 28	2.83	279
March 28	2.80	252	August 25	2.70	168
April 16	2.81	241	September 21	2.65	180
April 25	3.10	371	October 26	2.65	173
May 10	3.88	782	November 15	2.65	162
Do	3.88	758	December 27	2.55	162

Daily gage height, in feet, of Logan River near Logan, Utah, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.65	2.60	2.60	2.80	3.30	4.05	3.30	2.85	2.70	2.65	2.65	2.60
2	2.65	2.65	2.60	2.85	3.30	4.00	3.25	2.80	2.70	2.65	2.65	2.60
3	2.70	2.65	2.60	2.90	3.35	4.10	3.25	2.80	2.70	2.65	2.65	2.60
4	2.70	2.65	2.60	2.85	3.40	4.05	3.20	2.80	2.70	2.65	2.65	2.60
5	2.70	2.60	2.60	2.80	3.55	4.00	3.20	2.80	2.70	2.65	2.65	2.60
6	2.70	2.60	2.60	2.85	3.65	4.00	3.15	2.80	2.70	2.65	2.65	2.60
7	2.70	2.60	2.60	2.90	3.70	4.00	3.15	2.80	2.70	2.65	2.65	2.60
8	2.70	2.60	2.60	2.90	3.75	3.95	3.15	2.80	2.70	2.65	2.65	2.60
9	2.65	2.60	2.60	2.90	3.80	4.10	3.15	2.80	2.70	2.65	2.65	2.60
10	2.65	2.60	2.60	2.85	3.90	3.95	3.15	2.75	2.70	2.65	2.65	2.60
11	2.65	2.60	2.60	2.80	4.00	3.90	3.10	2.75	2.70	2.65	2.65	2.60
12	2.70	2.55	2.65	2.80	4.00	3.85	3.10	2.75	2.70	2.65	2.65	2.60
13	2.70	2.60	2.65	2.80	3.80	3.80	3.10	2.75	2.65	2.65	2.65	2.60
14	2.70	2.60	2.65	2.80	3.70	3.80	3.10	2.75	2.65	2.65	2.60	2.60
15	2.70	2.60	2.70	2.80	3.65	3.75	3.05	2.75	2.65	2.65	2.60	2.60
16	2.70	2.55	2.60	2.80	3.65	3.70	3.00	2.75	2.65	2.65	2.60	2.60
17	2.70	(a)	2.70	2.80	3.65	3.65	3.00	2.75	2.65	2.65	2.60	2.60
18	2.70	(a)	2.70	2.85	3.65	3.60	2.95	2.75	2.65	2.65	2.60	2.60
19	2.70	2.60	2.70	2.90	3.70	3.60	2.95	2.75	2.65	2.65	2.60	2.60
20	2.65	2.60	2.70	2.95	3.70	3.55	2.90	2.75	2.65	2.70	2.60	2.60
21	2.65	2.60	2.70	3.00	3.75	3.55	2.90	2.75	2.65	2.65	2.70	2.60
22	2.65	2.60	2.75	3.05	3.80	3.55	2.90	2.75	2.65	2.65	2.65	2.60
23	2.65	2.55	2.75	3.05	3.85	3.50	2.90	2.75	2.65	2.65	2.65	2.60
24	2.65	2.55	2.80	3.00	3.90	3.50	2.90	2.75	2.65	2.65	2.60	2.60
25	2.60	2.60	2.80	3.05	3.95	3.45	2.90	2.75	2.65	2.65	2.60	2.60
26	2.60	2.60	2.80	3.10	4.05	3.45	2.90	2.75	2.65	2.65	2.60	2.60
27	2.60	2.60	2.80	3.15	4.15	3.40	2.85	2.75	2.65	2.65	2.60	2.50
28	2.65	2.55	2.75	3.20	4.20	3.40	2.85	2.75	2.65	2.65	2.60	2.40
29	2.65	.....	2.75	3.25	4.15	3.35	2.85	2.75	2.65	2.65	2.60	2.55
30	2.65	.....	2.75	3.30	4.10	3.30	2.85	2.70	2.65	2.65	2.60	2.60
31	2.65	.....	2.75	.....	4.05	.....	2.85	2.70	.....	2.65	.....	2.60

a Gage out.

BLACKSMITH FORK AT HYRUM, UTAH.

This river is formed by the junction of several streams rising in the high mountains forming the southeastern boundary of Cache Valley. For the first 25 miles its course is in a northwesterly direction, through a precipitous canyon affording excellent water-power facilities. On leaving the canyon the stream enters Cache Valley, and finally joins Logan River a few miles above the junction of that river with Bear River. Six irrigation canals and one large power canal are supplied by this river, and during the irrigation season the entire supply is utilized. The present gaging station was established July 19, 1900, by George L. Swendsen. It is near the tollgate at the mouth of the canyon. Daily readings are made on a vertical gage. The bench mark, a line of red paint on the top of a short cedar post near the north post of the tollgate, is 8.29 feet above gage datum. During 1900 the following discharge measurements were made by Mr. Swendsen:

Discharge measurements of Blacksmith Fork at Hyrum, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
June 28	.....	240	October 19	3.10	126
July 19	3.20	147	November 16	3.05	129
August 29	3.10	122	December 27	2.90	115
September 25	3.12	129			

Daily gage height, in feet, of Blacksmith Fork at Hyrum, Utah, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.20	3.10	3.10	3.10	3.05	17	.....	3.10	3.10	3.10	3.05	3.00
2	.....	3.20	3.10	3.10	3.10	3.05	18	.....	3.10	3.10	3.10	3.05	3.00
3	.....	3.20	3.10	3.10	3.10	3.05	19	3.20	3.10	3.10	3.10	3.10	3.00
4	.....	3.20	3.20	3.10	3.10	3.05	20	3.20	3.10	3.10	3.10	3.10	3.00
5	.....	3.20	3.20	3.10	3.10	3.05	21	3.20	3.10	3.10	3.20	3.10	3.00
6	.....	3.20	3.50	3.10	3.10	3.05	22	3.20	3.10	3.10	3.20	3.10	3.00
7	.....	3.20	3.50	3.10	3.10	3.05	23	3.20	3.10	3.10	3.20	3.10	3.00
8	.....	3.20	3.50	3.10	3.05	3.05	24	3.20	3.10	3.10	3.50	3.10	3.00
9	.....	3.10	3.10	3.10	3.05	3.05	25	3.20	3.10	3.10	3.10	3.05	3.00
10	.....	3.10	3.10	3.10	3.05	3.05	26	3.20	3.10	3.10	3.10	3.05	3.00
11	.....	3.15	3.10	3.10	3.05	3.05	27	3.20	3.10	3.10	3.10	3.05	2.90
12	.....	3.15	3.10	3.10	3.05	3.00	28	3.20	3.10	3.10	3.10	3.05	2.90
13	.....	3.15	3.10	3.10	3.05	3.00	29	3.20	3.10	3.10	3.10	3.05	2.90
14	.....	3.15	3.10	3.10	3.05	3.00	30	3.20	3.10	3.10	3.10	3.05	2.90
15	.....	3.10	3.10	3.10	3.05	3.00	31	3.20	3.10	.....	3.10	.....	2.80
16	.....	3.10	3.10	3.10	3.05	3.00							

LITTLE BEAR RIVER, UTAH.

This stream has its source on the northern slopes of the mountains forming the southern boundary of Cache County, Utah. It flows in a northerly direction and enters Bear River a few miles below the mouth of Blacksmith Fork. On June 27, 1900, the east branch of Little Bear River was measured by George L. Swendsen, above all canal diversions, and a discharge of 37 second-feet was found. The south branch of the river was also measured on the same day, above all canal diversions, and a discharge of 40 second-feet was found.

BEAR RIVER NEAR COLLINSTON, UTAH.

This station, established July 1, 1889, is about 4 miles above the railroad station at Collinston, 2 miles east of the town of Fielding, Utah, and below the headworks of the Bear River canal. It is described in Water-Supply Paper No. 38, page 335. The record during the summer of 1900 shows the lowest discharge since the establishment of the station. A large canal is in process of construction, which will divert water a considerable distance above the Battlecreek station, to irrigate a large tract of land on the west side of Cache Valley. Its operation will greatly modify the discharge at the Collinston station during the next season. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 320; for 1897, Nineteenth Annual Report, Part IV, page 435; for 1898, Twentieth Annual Report, Part IV, page 460; for 1899, Twenty-first Annual Report, Part IV, page 395. The following discharge measurements were made during 1900:

Discharge measurements of Bear River near Collinston, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1900.	*Feet.*	*Sec.-ft.*
February 17	1.90	1,567	July 26	0.80	627
March 5	2.50	.....	August 28	.89	542
March 31	2.90	2,228	September 24	1.25	831
April 30	3.91	3,671	October 29	1.29	819
May 30	4.00	3,775	November 12	1.85	1,336
June 29	1.72	1,158	December 26	1.40	862

Daily gage height, in feet, of Bear River near Collinston, Utah, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.20	2.20	2.80	4.00	3.90	1.60	0.90	0.90	1.40	1.95	1.90
2	2.20	2.20	2.20	2.70	4.00	3.80	1.40	.90	.80	1.45	1.90	1.90
3	2.00	2.10	2.30	2.80	3.90	3.80	1.40	.80	.80	1.50	1.90	2.00
4	1.90	2.20	2.30	2.90	3.90	3.70	1.40	.80	.80	1.50	1.90	1.95
5	1.90	2.10	2.50	2.90	3.90	3.50	1.40	.80	.80	1.50	1.85	1.95
6	1.90	2.10	2.60	2.90	4.00	3.40	1.40	.80	.80	1.55	1.90	1.95
7	2.30	2.10	2.50	2.90	4.10	3.30	1.40	.80	.80	1.50	1.85	1.95
8	2.20	2.10	2.60	2.90	4.10	3.30	1.20	.70	.80	1.55	1.85	1.95
9	2.30	2.00	2.60	3.00	4.10	3.30	1.20	.70	.90	1.55	1.85	1.95
10	2.30	2.00	2.60	3.10	4.20	3.20	1.00	.70	1.00	1.55	1.85	2.00
11	2.20	1.90	2.60	3.10	4.20	3.30	.80	.80	1.15	1.60	1.85	2.00
12	2.20	2.00	2.70	3.00	4.30	3.30	.99	.80	1.25	1.60	1.85	2.00
13	2.30	2.10	2.80	3.10	4.50	3.10	.90	.80	1.20	1.60	1.85	1.90
14	2.40	2.10	2.90	3.00	4.60	2.90	.90	.80	1.10	1.60	1.85	1.90
15	2.70	2.00	2.90	3.00	4.60	2.90	.80	1.00	1.00	1.65	1.85	1.90
16	2.80	1.90	3.00	3.00	4.50	2.90	.80	1.00	1.00	1.65	1.85	1.85
17	2.80	1.90	3.10	2.90	4.40	2.80	.70	.90	1.00	1.65	1.85	1.85
18	2.70	1.80	3.20	2.90	4.30	2.50	.70	.90	1.00	1.65	1.95	1.85
19	2.60	1.90	3.30	2.80	4.20	2.40	.80	.90	1.05	1.65	2.00	1.85
20	2.60	2.10	3.40	2.80	4.00	2.30	.60	.90	1.10	1.65	2.00	1.85
21	2.50	2.30	3.60	2.80	3.90	2.30	.60	.90	1.15	1.95	2.00	1.90
22	2.40	2.20	3.60	3.00	3.90	2.20	.50	.90	1.15	1.75	2.60	1.90
23	2.20	2.20	3.40	3.10	3.80	2.00	.50	.90	1.20	1.90	2.40	1.90
24	2.30	2.20	3.30	3.10	3.80	2.00	.60	.90	1.25	1.90	2.25	1.85
25	2.30	2.10	3.10	3.10	3.80	1.90	.70	.90	1.30	1.85	2.15	1.85
26	2.20	2.20	3.10	3.20	3.80	1.90	.80	1.10	1.40	1.85	2.10	1.80
27	2.20	2.30	3.10	3.40	3.90	1.80	1.00	1.10	1.55	1.95	2.00	1.70
28	2.00	2.40	3.00	3.70	4.00	1.80	.90	1.00	1.50	1.95	2.05	1.60
29	2.00	.....	3.10	3.90	4.00	1.70	.90	.90	1.90	1.90	2.00	1.50
30	2.10	.....	3.00	3.90	4.00	1.70	.90	.90	1.40	1.95	1.95	1.40
31	2.10	.....	2.90	.....	4.00	.....	.90	.90	.....	1.95	.....	1.35

WEBER RIVER NEAR UINTA, UTAH.

This station, established in October, 1899, is in the canyon 5 miles east of Uinta, on the Union Pacific Railroad, immediately above the narrows known as Devils Gate. It is described in Water-Supply Paper No. 38, page 337. There are a number of good reservoir sites on the upper tributaries of the river, and within the last few years some of them have been utilized by the construction of notable storage works. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 324; for 1897, Nineteenth Annual Report, Part IV, page 440; for 1898, Twentieth Annual Report, Part IV, page 466; for 1899, Twenty-first Annual Report, Part IV, page 398. The following measurements were made during 1900:

July 16: Gage height, 1.15 feet; discharge, 76 second-feet.
August 22: Gage height, 1.05 feet; discharge, 75 second-feet.
September 29: Gage height, 1.35 feet: discharge, 172 second-feet.
October 22: Gage height, 1.70 feet; discharge, 401 second-feet.
November 12: Gage height, 1.73 feet; discharge, 426 second-feet.
December 29: Gage height, 1.50 feet; discharge, 356 second-feet.

Daily gage height, in feet, of Weber River near Uinta, Utah, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.40	1.10	1.30	1.70	1.60	17	1.10	1.20	1.20	1.50	1.70	1.50
2	.....	1.20	1.10	1.30	1.70	1.50	18	1.10	1.20	1.20	1.50	1.80	1.50
3	.....	1.15	1.10	1.30	1.70	1.50	19	1.10	1.20	1.25	1.50	1.85	1.50
4	.....	1.10	1.10	1.30	1.70	1.50	20	1.10	1.20	1.30	1.50	1.90	1.50
5	.....	1.15	1.10	1.30	1.70	1.50	21	1.10	1.20	1.30	1.60	2.40	1.50
6	.....	1.20	1.10	1.30	1.70	1.50	22	1.10	1.20	1.30	1.65	2.50	1.50
7	.....	1.20	1.10	1.30	1.60	1.50	23	1.10	1.20	1.30	1.70	2.50	1.50
8	.....	1.20	1.10	1.30	1.60	1.50	24	1.10	1.20	1.30	1.70	2.45	1.50
9	.....	1.20	1.20	1.30	1.60	1.50	25	1.10	1.20	1.30	1.70	2.20	1.50
10	.....	1.20	1.20	1.30	1.60	1.50	26	1.10	1.10	1.30	1.70	1.75	1.50
11	.....	1.20	1.20	1.30	1.60	1.50	27	1.10	1.10	1.30	1.70	1.60	1.50
12	.....	1.20	1.20	1.30	1.60	1.50	28	1.10	1.10	1.30	1.70	1.60	1.50
13	.....	1.20	1.20	1.30	1.60	1.50	29	1.25	1.10	1.30	1.70	1.60	1.50
14	.....	1.20	1.20	1.30	1.50	1.50	30	1.30	1.10	1.30	1.70	1.60	.....
15	.....	1.20	1.20	1.35	1.50	1.50	31	1.40	1.10	.....	1.70	.....	.....
16	1.10	1.20	1.20	1.45	1.60	1.50							

SPANISH FORK NEAR MAPLETON, UTAH.

This station, established by C. C. Babb on May 23, 1900, is in the canyon of the river 3 miles above the Rio Grande Western Railroad station at Mapleton, and a short distance above the head of the upper canal diverting water from the river. The gage rod consists of a vertical post driven firmly into the bed of the stream. The bench mark is at the top of the fourth large post, 4 rods northwest of the gate into the field west of the railroad track. The post is blazed on the north side and marked in pencil "U. S. G. S. Gage B. M." The bench mark is 250 feet northeast of the gage rod, and its elevation above the zero of the gage is 32.86 feet. The channel is straight for a short distance above and below the station. Both banks are high and are not subject to overflow. The bed of the stream is of gravel and is not likely to shift during high stages. Measurements were made by wading. The observer is Levi Thorpe, section foreman. During 1900 two measurements of discharge were made by C. C. Babb and W. P. Hardesty, as follows:

May 23: Gage height, 2.50 feet; discharge, 188 second-feet.
July 14: Gage height, 1.88 feet; discharge, 49 second-feet.

Daily gage height, in feet, of Spanish Fork near Mapleton, Utah, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.90	1.90	1.90	1.95	2.00	1.95
2	.....	1.90	1.85	1.90	1.95	2.00	1.90
3	2.35	2.00	1.85	1.90	1.95	2.00	2.00
4	2.35	2.00	1.85	1.90	1.95	.....	1.95
5	2.35	1.90	1.90	1.90	1.95	.....	1.95
6	2.25	1.90	1.90	1.90	1.95	.....	1.90
7	2.25	1.90	1.90	1.90	1.95	.....	1.95
8	2.25	1.90	1.90	1.90	1.95	.....	1.95
9	2.25	1.90	1.90	1.90	1.95	.....	.....
10	2.25	1.90	1.90	1.90	1.95	.....	.....
11	2.20	1.90	1.90	1.95	1.95	1.95	.....
12	2.50	1.90	1.90	1.95	1.95	1.95	.....
13	2.50	1.90	1.90	1.95	1.95	1.95	.....
14	2.50	1.90	1.90	1.90	1.95	1.95	.....
15	2.50	1.90	1.90	1.90	1.95	1.95	.....
16	2.50	1.90	1.90	1.90	1.90	2.00	.....
17	2.15	1.90	1.90	1.90	1.90	2.10	.....
18	2.10	1.90	1.90	1.90	1.90	2.05	.....
19	2.10	1.90	1.90	1.90	1.90	2.05	.....
20	2.10	1.90	1.90	1.95	1.95	2.00	.....
21	2.50	1.90	1.90	1.95	1.95	2.05	.....
22	2.50	1.90	1.90	1.95	1.95	2.00	.....
23	2.50	1.95	1.90	1.95	1.95	2.00	.....
24	2.00	1.95	1.90	2.05	1.95	2.00	.....
25	2.00	1.95	1.90	2.00	1.95	2.00	.....
26	2.00	1.90	1.90	2.00	1.95	2.00	.....
27	2.00	1.90	1.90	2.00	1.95	1.95	.....
28	2.00	1.90	1.90	2.00	1.95	1.95	.....
29	2.00	1.90	1.90	2.00	1.95	1.90	.....
30	2.00	1.90	1.90	1.95	1.95	2.00	.....
31	.....	1.90	1.90	.....	1.98	.....	.....

PROVO RIVER NEAR PROVO, UTAH.

This station, established July 27, 1889, is in the canyon about 6 miles from Provo, and above the head of most of the irrigation canals of Utah Valley. The observer is Henry V. Smith. The station is described in Water-Supply Paper No. 38, page 338. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 399. During 1900 the following measurements were made by C. C. Babb and W. P. Hardesty:

May 22: Gage height, 5.65 feet; discharge, 834 second-feet.
July 13: Gage height, 4.23 feet; discharge, 174 second-feet.
September 5: Gage height, 4.16 feet; discharge, 162 second-feet.
November 14: Gage height, 4.50 feet; discharge, 257 second-feet.

Daily gage height, in feet, of Provo River near Provo, Utah, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.2	4.3	4.2	4.2	4.3	4.5	4.8
2	.....	5.9	4.3	4.2	4.1	4.3	4.5	4.8
3	.....	5.7	4.3	4.2	4.1	4.3	4.5	4.8
4	.....	5.5	4.3	4.2	4.1	4.3	4.5	4.7
5	.....	5.4	4.3	4.2	4.1	4.3	4.5	4.6
6	.....	5.3	4.3	4.2	4.1	4.3	4.5	4.6
7	.....	5.2	4.3	4.2	4.1	4.3	4.5	4.6
8	.....	5.2	4.2	4.2	4.1	4.3	4.5	4.6
9	.....	5.1	4.2	4.2	4.2	4.3	4.5	.....
10	.....	5.1	4.2	4.2	4.2	4.3	4.5	.....
11	.....	4.1	4.2	4.2	4.2	4.3	4.5	.....
12	.....	4.9	4.2	4.1	4.2	4.3	4.5	.....
13	.....	4.9	4.2	4.1	4.2	4.3	4.5	.....
14	.....	4.8	4.2	4.1	4.2	4.3	4.5	.....
15	.....	4.7	4.2	4.1	4.2	4.3	4.5	.....
16	.....	4.6	4.2	4.1	4.2	4.3	4.8	.....
17	.....	4.5	4.2	4.1	4.2	4.3	4.8	.....
18	.....	4.5	4.2	4.1	4.2	4.3	4.8	.....
19	.....	4.4	4.2	4.2	4.2	4.4	5.0	.....
20	.....	4.4	4.2	4.2	4.2	4.4	5.6	.....
21	5.5	4.4	4.2	4.2	4.2	4.4	5.6	.....
22	5.7	4.4	4.2	4.2	4.2	4.4	5.6	.....
23	5.7	4.4	4.2	4.2	4.2	4.4	5.2	.....
24	6.0	4.3	4.2	4.2	4.3	4.5	5.0	.....
25	6.0	4.3	4.2	4.2	4.3	4.5	4.8	.....
26	6.1	4.3	4.2	4.2	4.3	4.5	4.8	.....
27	6.6	4.3	4.2	4.2	4.3	4.5	4.8	.....
28	6.5	4.3	4.2	4.2	4.3	4.5	4.8	.....
29	6.5	4.3	4.2	4.2	4.3	4.5	4.8	.....
30	6.4	4.3	4.2	4.2	4.3	4.5	4.8	.....
31	6.3	.....	4.2	4.2	.....	4.5	.....	.....

AMERICAN FORK NEAR AMERICAN FORK, UTAH.

This station, established by C. C. Babb on May 21, 1900, is 6 miles northeast of the town of American Fork, at the power plant which has been under course of construction during the last season. An old vertical rod, driven solidly into the bed of the river, was found here, and as it was in good condition it was used for recording heights. The rod is just above the tailrace of the new power plant, and observations were taken there until December 17, 1900, when the water wheels of the power company were started. After that the gage heights did not give the true flow, necessitating a change of location. About 200 feet below the tailrace of the power company is the three-partition measuring weir for dividing the water of the stream between the towns of Pleasant Grove, Lehi, and American Fork. On December 18, 1900, a rail was driven in the face of the weir structure, just south of the south opening and level with the crest of the weir, by which heights are recorded. This is not a sharp-edged weir, as the crest is 4 inches wide; but it is considered that the results will have an accuracy within 4 per cent. It is in good condition and seems to leak very little.

The following table gives the division of the water of the stream at the weir, according to court decrees, the data being furnished by the water master for the Lehi district:

Table showing division of waters of American Fork.

Season.	Town.	Width of opening.
		Feet.
September 20 to April 15	Pleasant Grove	2.5
Do	Lehi	5.5
Do	American Fork	25.0
		33.0
April 15 to July 1	Pleasant Grove	10.0
Do	Lehi	7.0
Do	American Fork	25.0
		42.0
July 1 to September 20	Pleasant Grove	8.0
Do	Lehi	14.0
Do	American Fork	20.0
		42.0

On December 18 levels were taken on the crest of the flashboards, and also on nails (one for each end of each opening) driven into the face of the longitudinal cap resting on the posts of the openings. By measuring down from these to the crest of the boards the elevation of the crest with reference to the gage point can be found without further use of the level. The reference nail for gaging is 0.012 foot too high for the present arrangement of the planks (division for September 20 to April 15), so that the gage readings by the observer are corrected by +0.01 foot. On December 27, 28, and 29 the river was frozen above the new gage, and observations were taken at the old stake. Readings were resumed at the new gage, however, on December 30, and during 1901 they will be taken at the weir gage.

During 1900 the following measurements of discharge were made by C. C. Babb and W. P. Hardesty:

May 21: Gage height, 0.70 foot; discharge, 138 second-feet.
July 13: Gage height, 0.39 foot; discharge, 42 second-feet.
September 5: Gage height, 0.25 foot; discharge, 26 second-feet.
November 14: Gage height, 0.29 foot; discharge, 24 second-feet.

Daily gage height, in feet, of American Fork near American Fork, Utah, for 1900.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.80	0.50	0.31	0.25	0.30	0.33	0.32
2	.....	.85	.50	.30	.25	.30	.33	.33
3	.....	.83	.50	.30	.26	.30	.33	.33
4	.....	.80	.50	.30	.28	.30	.33	.33
5	.....	.75	.50	.30	.27	.30	.33	.33
6	.....	.70	.48	.30	.27	.30	.33	.33
7	.....	.70	.48	.30	.27	.30	.33	.33
8	.....	.78	.42	.30	.27	.30	.33	.33
9	.....	.78	.40	.30	.30	.30	.33	.33
10	.....	.65	.40	.30	.30	.30	.33	.33
11	.....	.60	.40	.29	.30	.30	.32	.33
12	.....	.60	.40	.29	.30	.30	.32	.33
13	.....	.60	.40	.29	.30	.30	.32	.33
14	.....	.60	.40	.29	.30	.30	.30	.33
15	.....	.60	.40	.29	.30	.30	.30	.33
16	.....	.58	.40	.28	.25	.30	.30	.33
17	.....	.56	.40	.28	.24	.30	.30	.33
18	.....	.58	.40	.28	.24	.30	.30	*a* .37
19	.....	.51	.40	.24	.24	.30	.30	.37
20	.....	.53	.36	.24	.27	.35	.30	.37
21	0.73	.55	.33	.24	.30	.33	.30	.37
22	.75	.50	.34	.24	.30	.33	.30	.36
23	.76	.45	.35	.24	.30	.33	.30	.36
24	.85	.43	.35	.25	.38	.33	.30	.36
25	.90	.53	.35	.25	.30	.33	.32	.37
26	1.03	.50	.35	.25	.30	.33	.32	.36
27	1.03	.50	.35	.28	.30	.33	.32	*b* .30
28	.98	.50	.35	.28	.30	.33	.32	*b* .28
29	.90	.50	.34	.28	.30	.33	.32	*b* .28
30	.90	.50	.34	.27	.30	.33	.32	*a* .34
31	.80	.....	.34	.26	.....	.33	.....	*a* .34

a At new station on weir. *b* At old station on stake.

UTAH LAKE, UTAH.

A station for recording the rise and fall of this body of water was established November 6, 1896, by C. C. Babb, at Geneva, Utah. It was discontinued October 14, 1899. A description of it will be found in Water-Supply Paper No. 38, page 341. The city of Salt Lake has erected a new station at the outlet of the lake, plans and section of which will be found in the Twenty-first Annual Report, Part IV, pages 400 and 401. Observations were first started here on February 6, 1900, under the direction of the city engineer of Salt Lake, F. C. Kelsey, by whom the following record was supplied. To the figures given there should be added 4,500 feet in order to obtain the elevation of the surface of the water above sea level. The compromise level of this lake, as established by the lake commissioners, is at an elevation of 4,515.80 feet above the sea.

Daily gage height, in feet, of Utah Lake, Utah, near its outlet, for 1900.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		15.37		15.38	15.11						13.12
2				15.38		14.47	13.82				
3				15.38				13.16		12.83	
4											13.14
5					15.07						
6	15.37					14.38					13.19
7					15.06			13.08		12.80	
8					15.05				12.76		13.19
9					15.02	14.33	13.66				
10			15.34			14.32				12.82	13.19
11			15.34						12.75		
12	15.26				14.97	14.28		13.00			
13	15.20										13.21
14						14.26		12.95			
15				15.15					12.74	12.85	13.22
16			15.34						12.75	12.85	
17			15.34				13.48		12.79		
18			15.34	15.13	14.87	14.14	13.46		12.80		13.28
19		15.34	15.34		14.85			12.88			13.30
20	15.31	15.34				14.05					13.30
21		15.34				14.03					
22		15.34	15.34		14.80		13.35		12.80		
23			15.32			14.02					
24											13.40
25				15.10			13.28		12.79		
26		15.37		15.10				12.85			
27									12.76		
28		15.37									
29		15.36						12.84			
30		15.36	15.36		14.57						
31		15.40				13.85	13.22		12.76		13.40

CITY CREEK NEAR CITY OF SALT LAKE, UTAH.

This station is maintained by the engineering department of the city of Salt Lake, in connection with the water supply of that city, under the direction of Mr. F. C. Kelsey, city engineer, by whom the following record for 1900 was furnished:

Daily mean discharge, in second-feet, of City Creek near city of Salt Lake, Utah, for 1900.

[Drainage area, 19.15 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8	8	8	9	14	24	12	8	7	6	7	6
2	8	7	8	9	15	23	11	8	7	6	7	6
3	8	7	8	10	15	22	12	8	7	6	6	6
4	10	7	8	10	15	20	12	8	7	6	7	6
5	8	7	8	10	17	21	11	8	7	7	6	6
6	8	8	8	10	19	20	11	8	7	7	6	6
7	8	8	8	10	19	19	11	8	6	6	6	6
8	8	8	8	10	21	19	11	8	6	6	6	6
9	8	8	8	10	23	18	11	8	6	6	6	6
10	8	8	8	10	25	18	10	8	6	6	6	6
11	8	7	9	10	27	17	10	8	6	6	6	6
12	8	7	10	10	31	16	10	8	6	6	6	6
13	8	8	11	10	31	16	10	8	6	6	6	6
14	8	8	11	10	31	16	10	7	6	6	6	6
15	8	8	11	10	29	16	10	7	6	6	6	6
16	8	8	10	10	27	15	10	7	6	6	6	6
17	8	7	10	10	26	15	10	7	6	6	7	6
18	8	7	10	10	25	14	9	7	6	6	7	6
19	8	7	11	11	25	14	9	7	6	6	7	6
20	8	7	------	11	24	14	9	7	6	7	7	6
21	8	7	------	12	24	13	9	7	6	7	7	6
22	8	7	------	13	25	13	10	7	6	6	7	6
23	8	7	------	12	25	13	10	7	6	7	7	5
24	8	7	------	12	25	13	9	8	7	7	7	5
25	8	7	------	12	26	13	9	7	7	7	7	5
26	8	7	------	13	26	12	9	7	7	7	7	5
27	8	8	------	13	27	12	9	7	7	7	6	5
28	8	8	------	13	27	12	8	7	7	6	6	5
29	8	------	9	14	27	12	8	7	7	7	6	5
30	8	------	9	14	26	11	8	7	7	7	6	5
31	8	------	9	------	25	------	8	7	------	7	------	------
Mean	8	7	9	11	24	16	10	7	6	6	6	6

PARLEYS CREEK NEAR CITY OF SALT LAKE, UTAH.

This station was established by the engineering department of the city of Salt Lake in connection with the water supply of that city. It is in the canyon of the stream. Measurements are made over a double Cippoletti weir, which is so controlled that the entire weir can be lifted, allowing the gravel and deposit from above to be washed out from time to time. The following record for 1900 was furnished by Mr. F. C. Kelsey, city engineer of Salt Lake:

Daily mean discharge, in second-feet, of Parleys Creek near city of Salt Lake, Utah, for 1900.

[Drainage area, 50.14 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12	10	11	.....	30	24	14	6	6	8	8	9
2	13	10	12	.....	29	21	12	7	6	8	7	9
3	13	10	13	.....	29	20	12	10	4	8	7	9
4	16	10	13	.....	31	20	13	10	5	7	7	9
5	14	10	13	.....	39	20	13	10	5	8	7	9
6	13	10	13	19	39	18	11	8	6	10	7	9
7	13	10	13	21	.....	17	11	8	6	8	7	9
8	12	10	13	23	.....	18	11	8	6	8	7	9
9	12	10	13	23	.....	20	11	9	7	9	7	7
10	11	9	14	21	.....	18	10	8	7	9	7	8
11	11	11	16	20	.....	17	11	8	7	9	7	9
12	13	11	17	20	.....	17	10	8	7	9	7	8
13	15	11	19	21	.....	16	9	7	7	9	6	7
14	13	11	19	20	.....	16	9	7	7	8	6	6
15	14	9	18	19	29	16	9	7	7	8	6	8
16	13	9	19	18	28	15	8	6	6	8	5	7
17	12	9	19	15	29	15	8	6	7	8	7	8
18	12	12	18	15	27	15	9	6	7	8	6	8
19	12	11	19	15	27	15	9	6	7	8	9	8
20	11	11	19	18	27	15	8	6	7	12	8	8
21	11	11	18	21	27	15	8	6	7	10	10	8
22	11	11	18	23	26	13	9	6	7	9	12	8
23	12	10	19	21	25	13	9	6	7	9	12	6
24	11	11	19	20	24	13	8	8	10	11	10	7
25	8	11	19	18	23	12	8	8	9	10	10	9
26	9	12	20	21	23	13	8	8	9	10	10	8
27	11	12	20	23	22	13	7	7	9	9	9	8
28	10	12	16	25	25	11	7	7	9	9	8	8
29	11	.....	16	31	29	10	6	7	9	11	8	3
30	11	.....	16	31	27	11	6	6	8	10	8	4
31	10	.....	16	.....	25	.....	6	7	.....	8	.....	8
Mean	12	10	16	22	29	16	9	7	7	9	8	7

MILL CREEK NEAR CITY OF SALT LAKE, UTAH.

This station was established September 8, 1898, by the engineering department of the city of Salt Lake, in connection with the water supply of that city. Measurements are made over a Cippoletti weir in the canyon. The following record for 1900 was furnished by Mr. F. C. Kelsey, city engineer:

Daily mean discharge, in second-feet, of Mill Creek near city of Salt Lake, Utah, for 1900.

[Drainage area, 21.29 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	13	10	11	12	14	23	14	10	9	8	9	8
2	13	10	11	12	14	21	14	10	9	8	9	8
3	13	10	11	12	15	21	14	10	9	8	9	8
4	10	10	10	12	15	20	13	10	9	8	9	8
5	12	10	11	12	16	20	13	10	9	8	9	8
6	13	8	11	12	17	18	13	10	9	8	9	8
7	13	10	11	13	19	18	10	10	9	8	8	8
8	13	10	11	13	19	17	10	10	8	8	8	8
9	13	10	13	13	19	18	9	10	8	8	8	8
10	13	10	13	13	21	18	9	10	8	8	8	8
11	13	10	11	12	21	17	9	10	8	8	8	8
12	13	10	11	12	23	17	10	10	8	8	8	8
13	13	10	11	13	23	15	.....	10	8	8	8	8
14	13	10	12	12	21	15	10	10	8	8	8	8
15	13	10	12	12	20	15	10	9	8	8	8	8
16	13	11	12	12	22	15	10	9	8	8	8	8
17	13	11	12	12	22	14	10	9	8	8	9	8
18	13	11	12	12	21	14	10	9	8	8	9	8
19	13	9	12	12	20	14	10	9	8	8	9	8
20	12	9	12	12	20	14	10	9	.....	9	9	8
21	11	9	12	14	22	14	10	9	8	9	9	8
22	13	9	12	14	25	18	11	10	8	8	8	6
23	13	11	12	13	28	18	10	10	8	8	8	6
24	13	11	12	13	31	14	10	10	9	9	8	6
25	8	11	12	13	28	14	10	9	9	9	8	6
26	9	11	13	14	30	14	10	9	9	8	8	6
27	10	11	12	14	30	13	10	9	9	8	10	5
28	10	11	12	14	26	13	10	9	9	8	10	3
29	10	.....	12	14	26	13	10	9	8	8	10	3
30	10	.....	11	14	23	13	10	9	8	8	8	3
31	10	.....	11	.....	23	.....	10	9	.....	9	.....	1
Mean	12	10	12	13	22	16	11	10	8	8	9	7

BIG COTTONWOOD CREEK NEAR CITY OF SALT LAKE, UTAH.

This station was established October 30, 1898, by the city engineer of the city of Salt Lake, in connection with the water supply of that city. Measurements are made over a rectangular weir 16 feet long.

The following record for 1900 was furnished by Mr. F. C. Kelsey, city engineer:

Daily mean discharge, in second-feet, of Big Cottonwood Creek near city of Salt Lake, Utah, for 1900.

[Drainage area, 48.47 square miles.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	282	84	39	26	26	31	28
2	.....	277	75	33	26	25	32	28
3	.....	276	75	36	25	25	33	28
4	.....	255	78	37	27	27	30	28
5	.....	240	71	37	28	27	28	29
6	.....	237	71	36	24	28	31	29
7	.....	233	68	34	27	25	27	27
8	.....	250	65	35	25	26	27	26
9	.....	218	63	35	25	26	27	27
10	.....	190	64	33	25	27	27	27
11	.....	175	62	35	24	26	29	28
12	.....	168	60	33	25	25	26	26
13	.....	171	60	35	23	25	27	27
14	128	165	59	30	23	25	28	25
15	127	154	55	37	24	26	29	25
16	146	155	56	34	25	25	26	26
17	163	152	58	32	23	25	30	26
18	170	145	56	31	25	25	30	25
19	169	140	54	33	25	30	30	25
20	162	135	55	32	25	29	29	25
21	180	134	55	29	24	29	30	25
22	218	133	56	31	23	30	30	24
23	239	130	59	33	23	30	31	23
24	264	113	52	36	27	31	32	23
25	273	104	.....	38	27	27	28	22
26	288	107	.....	35	28	31	31	24
27	298	97	39	36	27	27	28	23
28	301	95	39	32	28	29	29	18
29	280	94	42	28	26	30	29	23
30	265	89	38	29	25	29	27	25
31	278	.....	38	30	.....	28	.....	14
Mean	219	170	59	34	25	27	29	25

SALINA CREEK NEAR SALINA, UTAH.

This stream drains a portion of the eastern part of Sevier County. It flows westerly and enters Sevier River near the town of Salina, Utah. A considerable portion of its waters is used for irrigation. The station, established by Caleb Tanner on July 2, 1900, is in the canyon of the creek, about 5 miles southeast of Salina. The gage consists of a vertical post driven into the bed of the creek and firmly braced on the downstream side. The bench mark is the top of a rock, set 12 inches in the ground, 80 feet northeast of the gage. Its elevation is 8.80 feet above gage datum. The bed of the stream is rough, containing bowlders, but it is fairly permanent. During 1900 the following measurements of discharge were made by Caleb Tanner:

July 2: Gage height, 1.05 feet; discharge, 11 second-feet.
July 23: Gage height, 1.08 feet; discharge, 12 second-feet.
September 8: Gage height, 1.02 feet; discharge, 8 second-feet.

Daily gage height, in feet, of Sevier River near Gunnison, Utah, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.50	0.63	0.63	0.80	0.90	0.95	17	0.73	0.60	0.63	0.81	0.85	0.98
2	.50	.63	.63	.80	.88	.95	18	1.10	.60	.63	.80	.93	.98
3	.55	.63	.63	.80	.88	.95	19	.83	.60	.63	.88	.98	.95
4	.63	.63	.80	.78	.85	.83	20	.78	.60	.63	.88	.90	.90
5	.75	.63	.70	.78	.85	.90	21	.80	.60	.63	.88	.90	1.10
6	.73	.63	.65	.78	.83	.90	22	.80	.60	.63	.85	.90	.88
7	.73	.63	.65	.78	.83	.88	23	.80	.60	.63	.85	.93	.83
8	.73	.63	.63	.78	.83	.88	24	.80	.60	.70	.85	.93	1.13
9	.73	.63	.63	.78	.83	.98	25	.65	.60	.75	.85	.93	1.00
10	.73	.63	.63	.78	.83	1.05	26	.70	.60	.75	.85	.93	1.00
11	.70	.63	.63	.78	.83	1.03	27	.70	.60	.75	.83	.93	1.13
12	.73	.63	.63	.78	.83	1.00	28	.65	.60	.80	.83	.93	1.13
13	.76	.63	.63	.78	.83	1.00	29	.65	.63	.80	.85	.93	1.15
14	.76	.60	.63	.78	.83	.95	30	.65	.63	.80	.85	.88	.....
15	.73	.60	.63	.80	.83	.95	31	.63	.63	.....	.90	.....	.....
16	.73	.60	.63	.83	.85	.95							

SNAKE RIVER AT MONTGOMERY FERRY, IDAHO.

This station, established October 5, 1895, is on the stage road from Minidoka to Albion. It is described in Water-Supply Paper No. 38, page 351. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 405. No records of gage heights were kept during 1900, and only one discharge measurement was made during the year, by N. S. Dils, as follows:

August 25: Gage height, 1.50 feet; discharge, 2,801 second-feet.

MALADE RIVER, IDAHO.

During 1899 stations were maintained on this river at Toponis and at Bliss, as described in Water-Supply Paper No. 38, pages 354 and 355. Results of measurements for that year will be found in the Twenty-first Annual Report, Part IV, pages 408 and 409. No stations were maintained on this river during 1900 and no discharge measurements were made. It is reported, however, that the low-water flow for that year did not vary greatly from that of 1899.

BRUNEAU RIVER NEAR GRANDVIEW, IDAHO.

This station, established by Mr. A. J. Wiley for the Owyhee Land and Irrigation Company, immediately below the headworks of the canal system of that company, 10 miles east of Grandview, is described in Water-Supply Paper No. 38, page 356. Records of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 341; for 1897, Nineteenth Annual Report, Part IV, page 450; for 1898, Twentieth Annual Report, Part IV, page 482; for 1899, Twenty-first Annual Report, Part IV, page 410. No measurements of discharge were made at this station during 1900.

Daily gage height, in feet, of Bruneau River near Grandview, Idaho, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.65	1.65	1.85	2.00	2.15	2.70	1.55	1.15	1.10	1.20	1.50	1.50
2	1.70	1.65	1.85	2.05	2.20	2.75	1.55	1.15	1.05	1.20	1.50	1.60
3	1.75	1.65	1.85	2.05	2.25	2.75	1.55	1.15	1.05	1.20	1.50	1.60
4	1.80	1.65	1.95	2.20	2.20	2.80	1.50	1.15	1.05	1.25	1.50	1.60
5	1.80	1.65	1.90	2.20	2.25	2.70	1.45	1.20	1.10	1.25	1.50	1.60
6	1.80	1.65	1.95	2.15	2.70	2.65	1.45	1.20	1.20	1.30	1.50	1.60
7	1.80	1.60	1.85	2.20	2.60	2.65	1.40	1.20	1.20	1.30	1.50	1.60
8	1.75	1.60	1.85	2.30	2.65	2.65	1.35	1.20	1.25	1.30	1.50	1.60
9	1.75	1.60	1.80	2.25	2.65	2.60	1.35	1.15	1.20	1.35	1.50	1.60
10	1.75	1.60	1.80	2.25	2.75	2.60	1.35	1.15	1.20	1.35	1.50	1.55
11	1.70	1.65	1.85	2.25	2.90	2.55	1.30	1.15	1.15	1.35	1.50	1.55
12	1.70	1.65	2.00	2.25	3.00	2.40	1.30	1.15	1.15	1.35	1.50	1.60
13	1.70	1.65	2.10	2.25	3.10	2.35	1.30	1.15	1.15	1.35	1.50	1.60
14	1.75	1.65	2.25	2.15	3.00	2.30	1.30	1.10	1.15	1.35	1.50	1.55
15	1.80	1.60	2.30	2.20	3.20	2.25	1.25	1.10	1.15	1.40	1.50	1.55
16	1.85	1.60	2.30	2.20	2.85	2.25	1.25	1.10	1.15	1.40	1.50	1.55
17	1.85	1.60	2.25	2.10	2.80	2.20	1.20	1.10	1.15	1.40	1.50	1.60
18	1.90	1.55	2.25	2.15	2.85	2.20	1.20	1.10	1.15	1.40	1.50	1.60
19	1.80	1.60	2.25	2.15	2.20	2.10	1.20	1.10	1.20	1.40	1.50	1.60
20	1.75	1.65	2.25	2.15	2.80	2.00	1.20	1.10	1.20	1.40	1.50	1.60
21	1.75	1.70	2.25	2.25	2.75	2.00	1.20	1.05	1.20	1.40	1.55	1.60
22	1.70	1.75	2.25	2.25	2.70	1.95	1.15	1.05	1.15	1.40	1.55	1.60
23	1.65	1.90	2.25	2.25	2.80	1.90	1.15	1.05	1.15	1.40	1.55	1.55
24	1.65	2.00	2.20	2.25	2.75	1.90	1.15	1.05	1.15	1.50	1.55	1.55
25	1.65	1.85	2.20	2.20	2.80	1.85	1.15	1.00	1.20	1.50	1.60	1.55
26	1.60	1.80	2.25	2.15	2.80	1.80	1.15	1.00	1.20	1.50	1.60	1.55
27	1.60	1.90	2.25	2.15	2.80	1.70	1.15	1.00	1.20	1.50	1.60	1.55
28	1.50	1.90	2.20	2.10	2.85	1.65	1.15	1.05	1.20	1.50	1.50	1.50
29	1.50	.....	2.20	2.15	2.80	1.65	1.15	1.05	1.20	1.50	1.55	1.50
30	1.55	.....	2.15	2.10	2.75	1.60	1.15	1.05	1.20	1.50	1.55	.....
31	1.60	.....	2.15	.....	2.70	.....	1.15	1.05	.....	1.50	.....	.....

BOISE RIVER NEAR BOISE, IDAHO.

This station is described in Water-Supply Paper No. 38, page 356. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 411. During 1900 the New York Canal Company built a wing dam of timber and loose rock, headed about 150 feet below the station and extending from the north bank diagonally down and across the stream a distance of about 50 feet, in order to protect the north bank from erosion. The construction of this wing dam did not seem to interfere with the flow of the river at the station. During the year new cable supports were set, bench marks were carefully verified, and the following discharge measurements were made by N. S. Dils:

Discharge measurements of Boise River near Boise, Idaho.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-feet.*		*Feet.*	*Sec.-feet.*
April 18	4.30	5,701	July 28	1.30	1,108
June 6	4.95	7,853	August 7	1.05	871
June 14	3.80	5,391	September 20	.98	797
June 28	2.60	2,371	September 27	.98	810
July 13	1.85	1,644			

Daily gage height, in feet, of Boise River near Boise, Idaho, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.10	2.20	3.90	4.40	4.30	2.40	1.10	.85	1.00	1.40	1.30
2	2.00	2.10	2.30	4.50	4.50	4.30	2.30	1.08	.85	1.10	1.40	1.30
3	2.00	2.10	2.30	4.80	4.60	4.50	2.25	1.05	.83	1.10	1.40	1.20
4	1.90	2.10	2.40	4.60	4.80	4.60	2.20	1.05	.85	1.10	1.40	1.30
5	2.00	2.00	2.30	4.50	4.80	4.70	2.00	1.08	1.10	1.30	1.40	1.30
6	2.00	1.85	2.50	4.70	5.30	4.95	1.95	1.05	1.20	1.40	1.40	1.30
7	2.00	1.90	2.75	4.90	5.50	4.80	1.90	1.03	1.05	1.20	1.30	1.30
8	1.90	1.90	2.90	4.80	5.80	4.60	1.80	1.08	.95	1.15	1.30	1.30
9	1.70	2.00	3.40	4.50	5.90	4.60	1.80	1.08	.95	1.10	1.30	1.30
10	1.70	1.90	3.55	4.50	6.30	4.30	1.85	.90	.98	1.10	1.25	1.20
11	1.90	1.80	3.80	4.20	6.50	4.00	1.85	.88	1.05	1.10	1.20	1.20
12	2.20	1.80	4.25	4.40	6.50	3.85	1.85	.95	.88	1.10	1.15	1.10
13	2.20	1.80	4.25	4.70	5.20	3.85	1.80	.98	.88	1.08	1.20	1.10
14	2.60	1.80	4.20	4.30	5.20	3.85	1.75	1.00	.85	1.08	1.20	1.20
15	3.50	1.80	4.20	4.10	5.30	3.80	1.60	.93	.90	1.05	1.20	1.30
16	3.40	1.80	4.30	4.30	5.30	4.15	1.60	.90	.85	1.05	1.20	1.30
17	3.20	1.70	4.30	4.20	5.20	3.80	1.55	.93	.88	1.00	1.20	1.40
18	2.80	1.80	4.40	4.30	5.10	3.55	1.50	.90	.90	1.05	1.30	1.30
19	2.50	1.80	4.40	4.30	5.20	3.55	1.45	.88	.98	1.25	1.30	1.30
20	2.45	1.80	4.30	4.30	5.10	3.55	1.45	.90	.95	1.25	1.15	1.30
21	2.40	2.00	4.30	4.30	5.00	3.65	1.35	.88	.93	1.70	1.10	1.80
22	2.30	2.60	4.30	4.30	4.90	3.60	1.35	.88	.90	1.50	1.15	1.70
23	2.30	2.50	4.50	4.30	4.80	3.40	1.30	.95	.93	1.75	1.20	1.40
24	2.30	2.40	4.50	4.30	4.80	3.30	1.30	1.00	.90	1.55	1.30	1.30
25	2.00	2.30	4.50	4.30	4.70	3.20	1.40	1.05	.95	1.40	1.30	1.40
26	2.00	2.40	4.60	4.20	4.70	3.10	1.40	.98	.98	1.40	1.35	1.30
27	2.00	2.30	4.50	4.20	4.60	2.90	1.30	.95	1.00	1.40	1.40	1.30
28	2.00	2.30	4.00	4.20	4.60	2.80	1.30	.95	1.00	1.33	1.20	1.10
29	2.00	.....	4.00	4.20	4.50	2.60	1.20	.88	.98	1.35	1.10	1.00
30	2.00	.....	3.90	4.30	4.50	2.50	1.18	.90	1.00	1.30	1.20	1.10
31	2.00	.....	3.90	.....	4.40	.....	1.15	.90	.....	1.30	.....	1.20

MISCELLANEOUS DISCHARGE MEASUREMENTS IN BOISE VALLEY, IDAHO.

A series of miscellaneous measurements of Boise River and of canals taking water from it was also made by N. S. Dils, from September 25 to 29, 1900. A similar series of measurements was made in 1899 (see Water-Supply Paper No. 38, page 358) and in 1898 (see Twentieth Annual Report, Part IV, pages 485 to 488).

Miscellaneous discharge measurements of Boise River and other streams and canals in Boise Valley, Idaho.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
July 30	Boise River	Near Caldwell	65
September 25	Sebree canal	Near head	190
Do	Seitenburg slough	do	16
Do	Riverside canal	Caldwell road bridge	9
Do	Waste east of Caldwell	Near river	3
Do	Waste from Tenmile Creek	Lower road	15
Do	Boise River	Star Bridge	171
Do	Waste south of Star Bridge	Near river	20
September 26	Eureka canal	Fifty feet below head gate	26
Do	Phyllis canal	Five hundred feet below head gate.	46
Do	Settlers' canal	One thousand feet below head gate.	48
Do	Davis canal	Near head	28
Do	McCarty canal	One hundred feet below head	38
Do	Waste from Rossi canal	Near river	42
Do	Waste from electric-light works		25
Do	Rossi canal	Below waste gate	50
Do	Payne canal	do	4
Do	Ellis canal	Near head	37
September 27	Perault canal	Below waste gate	85
Do	Boise River	U. S. G. S. gaging station	810
Do	New York canal	Opposite gaging station	a 10
Do	Costin canal	Near head	7
Do	Ridenbaugh canal	Two hundred feet below head	252
Do	Lamburger & Ryan canal	Flume	1
Do	Waste from Cottonwood Creek	Near river	3
Do	Front street canal	Below waste gate	30
September 28	Waste from Carline power house	Road bridge	33
Do	Farmers' Union canal	Near head	67
Do	Waste	Below Soldiers' Home	7
Do	Dry Creek canal	Near head	26
Do	Waste from Dry Creek	Road bridge	5
Do	Middleton canal	Near head	70
Do	Middleton Mill slough	do	100
Do	Davis & Hart canal	Eagle Island	6
Do	Conway canal	do	6
Do	Pioneer canal	Near head	3
September 29	Middleton Water Company	do	32
Do	Waste	East Middleton Road bridge	86
Do	Waste from Willow Creek	Road bridge	8
Do	Waste	East of Caldwell, near river	4
Do	Boise River	Three hundred feet below Caldwell road bridge.	240

a Not used in computations.

Summary of miscellaneous discharge measurements in Boise Valley, Idaho.

	Second-feet.	
In river at Caldwell, below all canals	240	
Taken out by canals	1,177	
Total		1,417
In river above canals	810	
Return waters	251	
Total		1,061
Gain in 34 miles		356
Gain per mile, 1900		11
Gain per mile, 1899		11
Gain per mile, 1898		8

WEISER RIVER NEAR WEISER, IDAHO.

This station, established December 6, 1894, is described in Water-Supply Paper No. 38, page 359. The results of measurements for 1899 are given in the Twenty-first Annual Report, Part IV, page 413. The new gage rod from which observations are now made was located October 31, 1899. During 1900 the following measurements of discharge were made by N. S. Dils:

May 28: Gage height, 3.40 feet; discharge, 2,074 second-feet.
June 19: Gage height, 1.90 feet; discharge, 646 second-feet.
July 23: Gage height, 0.50 foot; discharge, 87 second-feet.
August 15: Gage height, 0.25 foot; discharge, 47 second-feet.

The second measurement on July 23 was made 1 mile above the regular station.

Daily gage height, in feet, of Weiser River near Weiser, Idaho, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.0	3.2	3.3	3.1	1.1	0.3	0.4	0.6	1.2	1.3
2	4.6	3.3	3.4	3.1	1.1	.3	.4	.7	1.2	1.3
3	5.0	3.6	3.4	3.0	1.1	.3	.4	.7	1.2	1.4
4	6.0	3.7	3.6	3.0	.9	.3	.4	.7	1.2	1.5
5	5.6	3.7	3.9	2.9	.9	.2	.4	.8	1.2	1.6
6	5.4	3.8	4.2	2.8	.9	.2	.5	.8	1.2	1.7
7	6.0	3.8	4.4	2.8	.9	.2	.5	.9	1.2	1.8
8	8.0	3.7	4.0	2.7	.9	.2	.6	.9	1.2	1.9
9	6.9	3.7	4.1	2.7	.9	.2	.6	.9	1.1	1.8
10	6.1	3.8	4.2	2.6	.9	.3	.6	.9	1.1	1.8
11	5.7	3.9	4.4	2.6	.8	.3	.5	.9	1.1	1.7
12	5.3	4.0	4.6	2.5	.8	.3	.5	.8	1.1	1.7
13	5.2	4.1	4.8	2.5	.8	.3	.5	.8	1.1	1.7
14	4.9	3.8	4.7	2.4	.8	.3	.5	.8	1.1	1.7
15	4.7	3.6	4.8	2.3	.7	.3	.5	.8	1.1	1.8
16	4.5	3.5	4.7	2.2	.7	.3	.5	.8	1.2	2.1
17	4.4	3.4	4.6	2.1	.7	.3	.5	.8	1.2	2.4
18	4.3	3.5	4.4	2.0	.7	.3	.5	.8	1.2	2.1
19	4.2	3.6	4.2	1.9	.6	.3	.5	.8	1.2	2.2
20	4.1	3.6	4.0	1.8	.6	.3	.5	1.0	1.2	2.4
21	4.1	3.7	3.9	1.7	.6	.3	.5	1.6	1.2	5.1
22	4.0	3.7	3.8	1.6	.5	.3	.5	1.6	1.2	4.1
23	4.0	3.6	3.7	1.5	.5	.3	.5	1.5	1.2	3.3
24	4.0	3.5	3.6	1.4	.5	.3	.6	1.5	1.2	2.9
25	3.9	3.4	3.5	1.4	.5	.3	.6	1.4	1.2	2.7
26	3.9	3.4	3.4	1.3	.4	.3	.6	1.4	1.3	2.5
27	3.8	3.3	3.4	1.3	.4	.3	.6	1.2	1.3	2.3
28	3.7	3.3	3.4	1.2	.4	.4	.6	1.2	1.3	2.0
29	3.5	3.3	3.3	1.2	.4	.4	.6	1.1	1.3	1.9
30	3.4	3.3	3.2	1.1	.4	.4	.6	1.1	1.3	1.9
31	3.3	.....	3.2	.....	.3	.4	.....	1.2	.....	1.5

BLACKFOOT RIVER NEAR BONNER, MONTANA.

This station, established July 7, 1898, is at the wagon bridge one-half mile west of Bonner. It is described in Water-Supply Paper No. 38, page 362. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 416. During 1900 the following measurements of discharge were made by Prof. F. D. Smith and George Westby:

March 17: Gage height, 1.05 feet; discharge, 1,094 second-feet.
May 30: Gage height, 3.80 feet; discharge, 4,592 second-feet.
December 15: Gage height, 0.50 foot; discharge, 565 second-feet.

Daily gage height, in feet, of Blackfoot River near Bonner, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.70	0.60	0.50	1.30	3.20	3.45	1.90	0.95	0.90	0.70	0.60	(a)
2	.70	.50	.50	1.40	3.50	3.55	1.85	.95	.80	.70	.60	.....
3	.80	.50	.55	1.45	3.50	3.55	1.80	.90	.80	.70	.65	.....
4	.75	.50	.40	1.80	3.60	3.55	1.70	.90	.80	.70	.60	.....
5	.65	.55	.15	2.05	4.00	3.35	1.70	.90	.80	.70	.65	.....
6	.55	.45	.20	2.35	4.30	3.50	1.60	.90	.80	.70	.70	1.00
7	.70	.50	.30	2.50	4.35	3.35	1.60	.90	.80	.60	.65	.90
8	.65	.40	.55	2.60	4.30	3.20	1.55	.90	.80	.60	.65	.70
9	.65	.35	.80	2.65	4.10	3.20	1.50	.85	.70	.70	.65	.60
10	.65	.45	1.55	2.55	4.35	3.10	1.50	.95	.70	.70	.70	.55
11	.65	.55	2.15	2.55	4.60	2.95	1.40	.90	.80	.60	.65	.65
12	.55	.55	2.85	2.50	5.15	2.85	1.40	.80	.80	.60	.60	.55
13	.85	.40	2.95	2.45	6.90	2.80	1.40	.80	.80	.60	.65	.55
14	.80	.40	2.15	2.35	6.40	2.85	1.40	.80	.80	.60	.55	.55
15	.75	.35	1.85	2.45	5.90	2.85	1.30	.80	.70	.60	.60	.50
16	.75	.25	1.65	2.50	5.40	2.95	1.35	1.00	.70	.70	.60	.50
17	.65	.45	1.70	2.50	5.55	3.25	1.35	.80	.70	.85	.65	.40
18	.75	.35	1.35	2.50	5.50	3.20	1.25	1.00	.80	.65	.50	.45
19	.75	.55	1.40	2.70	5.35	2.95	1.20	.80	.70	.55	.55	.45
20	.60	.50	1.10	2.85	5.00	2.80	1.25	.75	.70	.55	(a)	.50
21	.65	.50	1.05	3.00	4.85	2.85	1.20	.80	.80	.50	.....	.75
22	.70	.55	1.05	3.05	4.80	2.75	1.15	.80	.70	.60	.....	.80
23	.60	.55	1.15	3.25	4.50	2.65	1.05	.80	.70	.55	.....	.65
24	.50	.50	1.25	3.35	4.50	2.60	.95	.80	.70	.65	.....	.70
25	.55	.50	1.20	3.30	4.30	2.50	.95	.80	.70	.55	.....	.65
26	.60	.40	1.15	3.30	4.05	2.35	1.10	.80	.60	.60	.....	.70
27	.50	.45	1.25	3.30	4.00	2.25	1.20	.80	.60	.70	.....	.65
28	.55	.45	1.30	3.15	3.95	2.15	1.00	.80	.70	.65	.....	.55
29	.55	.....	1.15	3.10	3.95	2.10	1.00	.75	.70	.60	.....	.55
30	.60	.....	1.20	3.05	3.85	1.95	1.05	.85	.70	.65	.....	.55
31	.60	.....	1.30	.....	3.50	.....	1.05	.75	.....	.60	.....	.40

a November 20 to December 6 slush ice blocking channel.

RATTLESNAKE CREEK AT MISSOULA, MONTANA.

This station, established May 27, 1899, is at the Ivy street bridge in the center of the city. It is described in Water-Supply Paper No. 38, page 363. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 417. During the blizzard in the latter part of November, 1900, the wire gage was broken, and readings were discontinued. During 1900 the following measurements of discharge were made by Prof. F. D. Smith:

May 19: Gage height, 4.27 feet; discharge, 704 second-feet.
June 18: Gage height, 4.13 feet; discharge, 645 second-feet.

Daily gage height, in feet, of Rattlesnake Creek at Missoula, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.60	2.63	2.40	3.20	3.95	3.68	3.05	2.18	2.35	2.53	2.45
2	2.60	2.60	2.40	3.43	4.15	3.65	2.98	2.20	2.35	2.55	2.45
3	2.60	2.45	2.40	3.63	4.40	3.75	2.90	2.20	2.35	2.53	2.48
4	2.60	2.43	2.40	4.05	4.88	3.85	2.90	2.18	2.35	2.58	2.65
5	2.58	2.43	2.45	3.95	4.85	3.90	2.90	2.20	2.33	2.58	2.60
6	2.55	2.75	2.40	3.83	4.78	3.88	2.85	2.20	2.33	2.58	2.60
7	2.58	2.35	2.45	3.85	4.68	3.88	2.78	2.18	2.30	2.60	2.55
8	2.55	2.35	2.43	3.73	4.70	3.83	2.75	2.20	2.30	2.55	2.55
9	2.53	2.40	2.50	3.63	4.83	3.63	2.68	2.20	2.30	2.55	2.58
10	2.50	2.43	2.50	3.50	4.93	3.58	2.53	2.18	2.30	2.55	2.55
11	2.53	2.45	2.58	3.30	5.23	3.53	2.48	2.18	2.30	2.58	2.53
12	2.55	2.38	.....	3.40	6.00	3.53	2.38	2.20	2.28	2.55	2.50
13	2.80	(a)	.....	3.38	5.60	3.53	2.35	2.18	2.25	2.55	2.50
14	2.85	(a)	2.95	3.43	4.73	3.48	2.35	2.15	2.25	2.55	2.50
15	2.85	(a)	2.95	3.40	4.40	3.53	2.33	2.15	2.25	2.53	2.50
16	2.83	(a)	2.95	3.45	4.40	3.70	2.35	2.15	2.25	2.50	2.50
17	2.80	(a)	2.98	3.45	4.50	4.08	2.35	2.15	2.33	2.50	2.55
18	2.73	(a)	3.05	3.60	4.43	4.53	2.30	2.15	2.53	2.48	(b)
19	2.70	(a)	3.13	3.80	4.17	4.03	2.25	2.15	2.53	2.48	.....
20	2.63	(a)	3.15	3.83	4.20	3.83	2.30	2.15	2.50	2.48	.....
21	2.68	2.40	3.08	3.80	4.13	3.88	2.25	2.18	2.53	2.50	.....
22	2.63	2.35	3.10	4.03	4.17	3.78	2.25	2.20	2.55	2.58	.....
23	2.58	2.40	3.18	3.90	4.00	3.58	2.23	2.20	2.70	2.60	.....
24	2.55	2.40	3.18	3.83	4.00	3.60	2.23	2.25	2.80	2.55	.....
25	2.60	2.45	3.20	3.80	3.93	3.63	2.20	2.30	2.78	2.53	.....
26	2.75	2.43	3.25	3.85	3.98	3.60	2.25	2.50	2.73	2.55	.....
27	2.58	2.40	3.18	3.70	4.03	3.35	2.28	2.45	2.68	2.53	.....
28	3.15	2.40	3.13	3.70	3.93	3.30	2.23	2.35	2.63	2.53	.....
29	2.50	.....	3.13	3.70	3.78	3.18	2.20	2.33	2.58	2.58	.....
30	2.55	.....	3.05	3.85	3.68	3.13	2.20	2.35	2.55	2.50	.....
31	2.58	.....	3.00	.....	3.70	.....	2.20	2.35	.....	2.45	.....

a Ice. *b* Gage broken; readings discontinued.

MISSOULA RIVER AT MISSOULA, MONTANA.

Missoula River is generally regarded as formed by the junction of Blackfoot and Hellgate rivers at Bonner, Montana. Hellgate River was measured by Prof. F. D. Smith on June 21, 1900, below Bonita, at the wagon bridge a short distance above the mouth of Rock Creek, and a discharge of 1,028 second-feet was found. Rock Creek is an important tributary of Hellgate River, entering it a few miles below Bonita. It was measured by Professor Smith on June 21, 1900, about 6 miles above its mouth and about 3 miles below Quigley, and a discharge of 1,670 second-feet was found. This creek is about 100 miles long, and in spring is a fierce torrent. At all times it probably carries more water than Hellgate River.

The Missoula River station at Missoula was originally established July 10, 1898, at the Higgins avenue bridge in the city. Owing to the occurrence of two channels in this section, on May 27, 1899, the station was moved, being placed below the junction of the two branches and 150 yards east of the railroad bridge. During 1900 observations of gage heights were taken on this lower rod. The station is described in Water-Supply Paper No. 38, page 364. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 418. During 1900 the following measurements of discharge were made by Prof. F. D. Smith and George Westby:

June 18: Gage height, 6.25 feet; discharge, 8,164 second-feet.
December 22: Gage height, 3.80 feet; discharge, 1,710 second-feet.

Daily gage height, in feet, of Missoula River at Missoula, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	3.58	4.23	5.98	6.80	4.68	3.48	3.38	3.50	3.60	(a)
2	(a)	(a)	3.60	4.33	6.08	6.70	4.63	3.43	3.35	3.55	3.60	(a)
3	(a)	(a)	3.55	4.63	6.25	6.70	4.53	3.48	3.40	3.53	3.60	(a)
4	(a)	(a)	3.45	4.83	6.45	6.65	4.40	3.43	3.38	3.68	3.65	(a)
5	(a)	(a)	3.10	5.08	6.73	.....	4.35	3.35	3.48	3.63	3.68	3.88
6	(a)	(a)	3.15	5.20	6.95	.....	4.35	3.35	3.48	3.60	3.65	3.85
7	(a)	(a)	3.45	5.40	7.10	6.45	4.33	3.30	3.55	3.68	3.65	3.80
8	(a)	(a)	3.60	5.30	6.98	6.45	4.25	3.30	3.50	3.65	3.65	3.80
9	(a)	(a)	4.30	5.33	6.90	6.33	4.20	3.35	3.48	3.60	3.63	3.70
10	(a)	(a)	4.85	5.23	7.23	6.28	4.13	3.25	3.45	3.60	3.65	3.63
11	(a)	(a)	5.63	5.20	7.65	6.05	4.08	3.40	3.45	3.58	3.58	3.53
12	(a)	(a)	6.10	5.20	9.45	5.88	4.03	3.35	3.40	3.55	3.50	3.45
13	3.70	(a)	5.90	5.13	9.45	5.78	3.98	3.35	3.38	3.55	3.50	3.40
14	3.90	(a)	5.05	5.18	9.05	5.65	3.95	3.33	3.35	3.53	3.53	3.40
15	3.73	(a)	4.75	5.15	8.63	5.70	3.90	3.30	3.38	3.55	3.50	3.45
16	3.68	(a)	4.27	5.23	8.30	5.78	3.85	3.30	4.15	3.55	3.50	3.43
17	3.58	2.55	4.40	5.23	8.43	6.05	3.83	3.20	3.63	3.53	3.63	3.45
18	3.60	3.05	4.33	5.20	8.40	6.28	3.80	3.23	3.65	3.50	(a)	3.43
19	3.60	(a)	4.07	5.33	8.23	5.93	3.75	3.23	3.70	3.53	(a)	3.40
20	3.60	(a)	4.15	5.48	8.15	5.80	3.65	3.20	3.68	3.53	(a)	3.43
21	3.63	(a)	4.18	5.58	7.85	5.65	3.58	3.15	3.65	3.50	(a)	3.68
22	3.58	3.55	4.23	5.75	7.68	5.63	3.53	3.35	3.60	3.60	(a)	3.85
23	3.58	3.58	4.35	5.85	7.63	5.50	3.58	3.38	3.60	3.60	(a)	3.60
24	3.55	3.68	4.25	5.90	7.48	5.45	3.55	3.43	3.65	3.60	(a)	3.50
25	3.33	3.68	4.23	5.90	7.33	5.40	3.58	3.48	3.60	3.58	.....	3.43
26	2.95	3.65	4.28	5.95	7.17	5.40	3.58	3.50	3.60	3.55	(a)	3.40
27	3.10	3.65	4.28	5.95	7.18	5.20	3.55	3.50	3.60	3.53	(a)	3.43
28	2.85	3.65	4.28	5.90	7.20	5.05	3.55	3.43	3.58	3.55	(a)	3.30
29	(a)	.....	4.20	5.90	7.10	4.90	3.58	3.40	3.58	3.63	(a)	3.13
30	(a)	.....	4.10	5.90	6.95	4.78	3.50	3.45	3.50	3.58	(a)	3.10
31	(a)	.....	4.15	.....	6.85	.....	3.50	3.43	.....	3.60	.....	(a)

a Ice.

BITTERROOT RIVER AT MISSOULA, MONTANA.

This station, established July 6, 1898, is at the Buckhouse wagon bridge. The gage was verified June 19, 1900, and the length of cable was found to be 22.83 feet. On December 1, 1900, the wire was again tested, and was found to measure 22.95 feet, showing a stretch of 0.12 foot, which was not corrected. The station is described in Water-Supply Paper No. 38, page 368. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 420. During 1900 the following measurements of discharge were made by Prof. F. D. Smith and George Westby:

March 17: Gage height, 2.40 feet; discharge, 1,875 second-feet.
December 15: Gage height, 1.60 feet; discharge, 1,185 second-feet.

Lolo Creek is a tributary of Bitterroot River, entering it from the west, about 12 miles above its mouth. On June 18, 1900, it was measured by Professor Smith, at Littleman's bridge, 5 miles above the Lolo post-office and above all ditches, and a discharge of 609 second-feet was found.

Daily gage height, in feet, of Bitterroot River at Missoula, Montana, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.70	(b)	2.40	(b)	5.30	3.60	1.30	1.50	1.60	2.35	1.55
2	1.60	1.70	(b)	2.50	(b)	5.35	3.40	1.30	1.50	1.50	2.40	1.55
3	1.55	1.70	(b)	2.90	5.00	5.60	3.30	1.25	1.40	1.50	2.40	1.55
4	1.55	1.60	1.20	3.25	5.25	5.90	3.00	1.20	1.30	1.60	2.20	1.55
5	1.60	1.45	1.25	3.60	5.80	6.10	2.90	1.15	1.30	1.60	2.10	1.60
6	1.60	1.40	1.25	3.75	6.10	6.30	2.85	1.10	1.40	1.55	2.10	1.60
7	1.60	1.35	1.35	3.85	6.50	6.45	2.85	1.10	1.45	5.60	1.90	1.70
8	1.60	1.30	1.45	3.70	6.40	6.00	2.85	1.10	1.45	5.65	1.80	1.80
9	1.55	1.30	1.50	3.55	6.15	5.80	2.70	1.10	1.40	5.65	2.00	1.70
10	1.50	1.35	1.50	3.50	6.55	5.50	2.65	1.10	1.40	5.60	1.80	1.70
11	1.50	(a)	1.70	3.45	7.10	5.00	2.65	1.10	1.40	5.60	1.70	1.60
12	1.55	(a)	1.75	3.40	7.65	4.90	2.40	1.05	1.35	5.60	1.65	1.55
13	1.60	(a)	1.80	3.45	8.50	4.90	2.30	1.05	1.35	5.50	1.65	1.50
14	1.80	(a)	1.90	3.40	7.80	4.80	2.30	1.05	1.30	1.45	1.60	1.50
15	2.00	(a)	1.95	3.40	6.80	4.80	2.20	1.05	1.30	1.45	1.60	1.50
16	2.00	(a)	2.15	3.50	6.30	5.80	2.10	1.05	1.30	1.40	1.60	1.50
17	1.90	(a)	2.30	3.70	6.35	5.65	2.00	1.05	1.30	1.40	1.60	1.60
18	1.85	(a)	2.40	3.95	6.40	5.50	1.90	1.05	1.30	1.45	1.60	1.60
19	1.80	(a)	2.45	4.00	6.45	5.40	1.85	1.00	1.30	1.45	(a)	1.70
20	1.80	(a)	2.50	4.05	6.10	5.15	1.85	1.00	1.70	1.50	(a)	1.70
21	1.70	(a)	2.50	4.10	5.70	5.30	1.70	.90	1.70	1.60	(a)	1.70
22	1.65	(a)	2.55	4.20	5.80	5.40	1.65	.90	1.70	1.70	(a)	1.70
23	1.65	(a)	2.55	4.10	5.70	5.45	1.60	.90	1.65	1.80	(a)	1.70
24	1.65	(a)	2.60	4.00	5.65	5.40	1.60	1.00	1.70	1.90	(a)	1.60
25	1.55	(a)	2.60	3.90	5.60	5.50	1.55	1.00	1.70	1.60	1.70	1.60
26	1.55	(a)	2.70	3.90	5.60	5.10	1.55	1.00	1.80	2.00	1.60	1.60
27	1.55	(a)	2.60	3.85	5.65	4.70	1.55	1.05	1.80	2.20	1.60	1.50
28	1.60	(a)	2.50	3.85	5.65	4.30	1.55	1.10	1.80	2.25	1.60	1.40
29	1.60	(a)	2.55	(b)	5.65	4.00	1.55	1.10	1.70	2.25	1.60	1.30
30	1.60	(a)	2.40	(b)	5.35	3.90	1.40	1.30	1.70	2.30	1.55	1.30
31	1.70	(a)	2.40	(b)	5.15	.....	1.35	1.40	.....	2.35	.....	1.30

a Frozen. *b* No record.

FLATHEAD LAKE, MONTANA.

On the western slope of the Rocky Mountains in northwestern Montana, in the vicinity of Columbia Falls, three large streams combine to form the upper Flathead River, which flows through a rich, fertile valley for a distance of about 40 miles, and empties into the northern end of Flathead Lake. The several tributaries of the river drain a large area, a portion of which extends northward into Canada. The drainage basin is entirely mountainous, and is in a region of heavy snowfall. Swan River flows northwardly behind the Mission range of mountains, which rise abruptly on the eastern shore of the lake, until it finally rounds the northern end of the range and empties into the lake within 3 miles of the mouth of Flathead River. These two rivers supply nearly all of the water which flows into Flathead Lake, the other sources being small creeks.

Flathead Lake is a large body of fresh water, its north-south length about 30 miles, its width varying from 6 to 15 miles. It is said to be very deep, although probably no reliable soundings have been made. At its northern end Flathead River, which carries immense quantities of silt, has formed a delta or bar. Swan River, on the contrary, is a clear stream, and carries little silt into the lake. At the southern end the outlet of the lake is Flathead River, a tributary of Clark Fork of the Columbia.

The valley of Flathead River requires no irrigation, its rich, alluvial soil producing abundant crops without the aid of water. On the

contrary, it often suffers from too much water, by inundation from the river when, after a winter of heavy snowfall, a mild spring, with its accompaniment of chinook winds, causes too rapid melting of the snow to produce overflow. The river has very little fall, causing a slow current; its course is sinuous; its banks are not high, and behind them the valley is quite level; and with its mouth partially dammed by its own deposits of silt it is not surprising that overflows have occurred and will continue to occur until some method is adopted to allow the flood waters to escape before rising to the top of the banks. Several plans have been suggested to remedy the evil, but until measurements have been obtained of the flow of the water in the lake, and particularly of the amount of flood water to be provided against, it is impossible to arrive at a conclusion. It will also be necessary to determine the quantity of water passing out of the lake and the amount of evaporation. Level lines should be run and a topographic map of the area be prepared, after which it may be possible to determine a feasible plan for the relief of the farming land in the valley of the river.

During the summer of 1900 a reconnaissance trip encircling Flathead Lake was made by Prof. F. D. Smith. Besides the two main streams at the head of the lake—Flathead River and Swan River—a number of minor streams discharge into this body of water. Among these are Dayton Creek, which drains a small area on the west side of the lake, discharging into it south of the town of Dayton. There is a considerable body of agricultural land located in the valley of this creek, most of it within the Flathead Indian Reservation, and not at present available for settlement by whites. Lake Ronan, which is 3 miles long and a half mile wide, is within the drainage area of Dayton Creek, and is reported to be a good reservoir site. Dayton Creek was measured on June 26, 1900, immediately above its mouth, and a discharge of 31 second-feet was found. It is reported that this stream is often dry during September.

Big Creek enters the lake from the west, about halfway between the upper end of the lake and the northern boundary line of the Flathead Indian Reservation. It was measured on June 26, 1900, and a discharge of 38 second-feet was found. It is reported that this is the average amount of water that this stream carries during the remaining months of the year. Dayton Creek and Big Creek are the only streams of importance entering Flathead Lake from the west. The first stream of importance on the east side of the lake and south of Swan River is Glen Creek, which on June 28, 1900, had a discharge of 4 second-feet near its mouth.

Continuing southward, the next stream of importance on the east side enters the lake near the ranch of H. N. Chapman, just below the northern boundary of the Indian reservation. Its discharge on June 29, 1900, was found to be 19 second-feet. Four miles to the south of

this stream there is a creek which on June 29 was carrying 10 second-feet. It enters the lake at the foot of the north end of the Blue Grade, a dangerous graded road along the lake shore. Four miles still farther south is another small stream, which on June 29, 1900, was discharging 20 second-feet. It enters the lake immediately north of the peninsula in the southeastern corner of the lake. The only stream of importance which enters the lake south of this peninsula was discharging 24 second-feet on June 29, 1900.

During this trip Professor Smith made measurements of a number of streams which enter the lower Flathead (Pend Oreille) River. They all are included within the Flathead Indian Reservation. Crow Creek was measured on June 30, 1900, at the highway bridge on the lower lake road, about 16 miles from St. Ignatius Mission, and was found to have a discharge of 180 second-feet. This stream, with Post and Mission creeks, will be of great value when the reservation is thrown open to settlement, as they carry a considerable amount of water throughout the year, and the many acres of arable lands can thus be served from them. Post Creek enters the lower Flathead River 10 miles south of Crow Creek. On June 30 it was measured about 2 miles above the mouth of Mission Creek, and a discharge of 473 second-feet was found. It has its source in a small lake 2 miles long and a half mile wide, locally known as McDonald Lake. This body of water could easily be transformed into a large reservoir to hold waters for all lands below. At the time of measurement Post Creek was carrying more than its normal summer discharge. Mission Creek is a tributary of Post Creek. It was measured on June 30 at the highway bridge in the limits of the village of St. Ignatius, and a discharge of 412 second-feet was found. This stream is used for irrigation more than the other two creeks, its waters serving the lands around the mission. The principal ditch is taken out about 1,000 feet above the highway bridge. It is 4.7 feet wide, with a capacity of 100 second-feet. At the time of the visit the ditch was carrying 24 second-feet. Jocko River, a tributary of lower Flathead River, was measured on June 30, at the Northern Pacific Railway bridge, and a discharge of 660 second-feet was found. Water from this stream is used to a limited extent for irrigation purposes in Jocko Valley, and also at the Indian agency near Arlee, where a ditch has been constructed by the Government for the use of the Indians.

SWAN RIVER NEAR HOLT, MONTANA.

This river lies in the basin or valley in northwestern Montana formed by the Swan Range on the east and the Mission Range on the west. It flows northerly, entering Flathead Lake at its upper end, within a short distance of the mouth of the upper Flathead River. During the season of 1900 private surveys were prosecuted, with the idea of developing the water power of this stream near its mouth and transmitting electric power to Kalispell, 15 miles distant, in an air

line. The gaging station, which was established by Prof. F. D. Smith on June 28, 1900, is at the highway bridge 3 miles east of Holt and a short distance above the mouth of the river. A wire gage was placed with a pulley distance of 1.23 feet and a length of cable from the end of the weight to the index marker of 21.65 feet. The bed of the river is rocky and gravelly. Above the station the stream has a considerable fall for a mile or more, making a long course of beautiful rapids. On June 28 a measurement of discharge was made by Professor Smith, and a gage height of 4.10 feet and discharge of 0.39 second-foot were found. The observer is E. L. Sliter, who also has charge of the gage at the lake.

Daily gage height, in feet, of Swan River near Holt, Montana, for 1900.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1		3.60	1.60	12		2.20		23		1.60	
2		3.50	1.50	13		2.10		24		1.60	
3		3.40	1.50	14		2.00		25		1.60	
4		3.30	1.40	15		2.00		26		1.70	
5		3.10	1.40	16		1.90		27		1.70	
6		2.90		17		1.90		28	4.10	1.70	
7		2.80		18		1.80		29	4.00	1.80	
8				19		1.70		30	3.70	1.80	
9		2.50		20		1.70		31		1.70	
10		2.30		21		1.60					
11		2.30		22		1.60					

FLATHEAD LAKE NEAR HOLT, MONTANA.

On April 24, 1900, Prof. F. D. Smith established a station on this lake near its head. The gage is a vertical rod fastened securely to the logs of the boathouse of the Flathead Club, of Helena. It is about 2 miles east of the mouth of Flathead River. Owing to the height of the lake at the time of the erection of the gage, an additional length will have to be added at the lower end when the level is at a lower stage. The lake was calm at the time of the erection of the gage, and read 7.05 feet; forty-four hours later the gage at Polson, at the lower end of the lake, read 7.15 feet. The observer is E. L. Sliter.

Daily gage height, in feet, of Flathead Lake near Holt, Montana, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Day.	Apr.	May.	June.	July.	Aug.
1		7.70	10.05	8.80	4.50	17		12.60	9.00	6.40	
2		7.80	9.80	8.60	4.40	18		12.20	8.90	6.00	
3		7.90	9.70	8.30	4.20	19		12.00	8.85	6.20	
4		7.95	9.70	8.10	4.00	20		11.70	8.90	6.00	
5		8.05	9.60	8.00	4.00	21		11.50	9.00	5.90	
6		8.30	9.53	7.80		22		11.30	9.00	5.80	
7		8.50	9.50	7.60		23		11.10	9.00	5.70	
8		9.00	9.40			24	7.00	11.00	9.08	5.50	
9		9.20	9.30	7.40		25	7.10	10.90	9.00	5.30	
10		9.50	9.30	7.30		26	7.20	10.80	9.00	5.20	
11		10.80	9.20	7.20		27	7.40	10.90	9.00	5.00	
12		10.60	9.20	7.10		28	7.50	10.60	8.90	4.80	
13		10.60	9.10	6.90		29	7.60	10.50	8.80	4.80	
14		10.80	9.00	6.80		30	7.65	10.20	8.90	4.70	
15		11.30	9.00	6.60		31		10.10		4.60	
16		12.00	9.00	6.50							

FLATHEAD LAKE AT POLSON, MONTANA.

This station, which is at the lower end of the lake, at the Polson post-office, was established by Prof. F. D. Smith on April 20, 1900 The gage is a 16-foot rod, graduated to feet and tenths, and nailed to a double pile of the abandoned steamboat pier near the outlet of the lake. From year to year the lake has a variation in height of perhaps 15 feet, and overflows much land at both ends. At the time of the erection of the gage the level of the low water was about 5 feet above the low-water mark of 1899 and 1890, and measurements made at an old submerged pier showed the water to be about 6 feet above the lowest stage remembered. The observer is Henry Therriault, postmaster and Indian trader at Polson.

Daily gage height, in feet, of Flathead Lake at Polson, Montana, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.70	10.05	8.75	5.40	4.00	4.10	5.10	3.50
2	.....	7.80	9.85	8.70	5.30	4.10	4.10	5.10	3.60
3	.....	7.90	9.70	8.60	5.20	4.10	4.10	5.10	3.70
4	.....	7.95	9.60	8.60	5.20	4.20	4.20	5.00	3.80
5	.....	8.25	9.50	8.50	5.20	4.30	4.20	4.90	3.80
6	.....	8.40	9.50	8.30	5.10	4.30	4.20	4.80	3.80
7	.....	8.60	9.50	8.05	5.10	4.30	4.20	4.80	3.80
8	.....	8.95	9.45	7.75	5.00	4.30	4.20	4.70	3.80
9	.....	9.15	9.40	7.60	4.90	4.30	4.10	4.60	3.90
10	.....	9.30	9.40	7.55	4.90	4.30	4.10	4.50	3.90
11	.....	9.45	9.40	7.35	4.80	4.20	4.10	4.50	3.90
12	.....	9.65	9.40	7.20	4.80	4.20	4.00	4.40	4.00
13	.....	10.05	9.30	7.05	4.70	4.20	4.00	4.40	4.00
14	.....	10.60	9.30	6.85	4.70	4.10	4.00	4.30	4.00
15	.....	11.10	9.20	6.70	4.60	4.10	4.00	4.20	4.00
16	.....	11.40	9.05	6.70	4.60	4.10	4.00	4.10	4.00
17	.....	11.65	8.95	6.70	4.50	4.10	4.00	4.00	4.00
18	.....	11.60	9.00	6.60	4.50	4.10	4.10	4.00	4.00
19	.....	11.55	9.00	6.50	4.50	4.10	4.10	4.00	4.00
20	6.50	11.60	9.00	6.35	4.40	4.00	4.20	3.90	4.00
21	6.65	11.60	9.05	6.15	4.30	4.00	4.20	3.80	4.00
22	.....	11.55	9.10	6.00	4.20	4.00	4.30	3.70	4.00
23	6.85	11.45	9.15	5.95	4.10	4.00	4.30	3.70	4.00
24	6.95	11.35	9.15	5.90	4.00	4.00	4.40	3.60	4.00
25	7.15	11.20	9.00	5.80	4.00	4.00	4.40	3.60	4.00
26	7.40	11.10	9.00	5.70	4.00	4.00	5.00	3.50	4.00
27	7.40	10.80	8.95	5.60	4.00	4.00	5.00	3.50	3.90
28	7.50	10.75	8.90	5.60	4.00	4.00	5.00	3.50	3.90
29	7.60	10.55	8.90	5.50	4.00	4.10	5.10	3.40	3.90
30	7.60	10.40	8.90	5.40	4.00	4.00	5.10	3.40	3.90
31	.....	10.20	.....	5.40	4.00	.....	5.10	.....	3.90

SPOKANE RIVER AT SPOKANE, WASHINGTON.

This station, established October 17, 1896, by C. C. Babb, is a short distance above the Spokane Falls, at the bridge of the Oregon Railway and Navigation Company. It is described in Water-Supply and Irrigation Paper No. 38, page 370. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 424. During 1900 three measurements of discharge were made by D. L. Huntington, general manager of the Washington Water Power Company, at the Division street bridge, within the limits of the city and a short distance below the bridge at which the regular gaging station is located. On September 15, when the height on the United

States Geological Survey rod was 1.6 feet, the water level at the Division street bridge, referred to the bottom of a certain I beam of the bridge, was 16.245 feet, and the discharge, as measured by a Price meter, was 2,029 second-feet. On October 13 the gage height was 1.80 feet, the water level at the Division street bridge, referred to the same datum, was 16.14 feet, and the discharge was 2,233 second-feet. On October 20 the gage height was 1.8 feet, the water level at the Division street bridge 16.09 feet, and the discharge 2,287 second-feet. During 1900 the following measurements of discharge were made at the regular station by Sydney Arnold:

May 17: Gage height, 6.5 feet; discharge, 13,613 second-feet.
June 14: Gage height, 4.1 feet; discharge, 7,493 second-feet.

Daily gage height, in feet, of Spokane River at Spokane, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.70	5.50	3.95	7.20	6.45	5.35	3.40	2.05	1.70	1.75	2.70	3.55
2	4.70	5.35	3.90	7.10	6.40	5.25	3.30	2.05	1.70	1.75	2.80	3.65
3	4.70	5.20	3.90	7.10	6.40	5.15	3.25	2.00	1.70	1.70	2.80	3.75
4	4.65	5.05	3.95	7.10	6.35	5.05	3.15	1.95	1.70	1.70	3.10	3.90
5	4.65	4.95	4.00	7.20	6.30	4.90	3.15	1.95	1.70	1.70	3.30	4.15
6	4.70	4.80	4.05	7.25	6.30	4.85	3.10	1.90	1.70	1.70	3.45	4.40
7	4.70	4.70	4.15	7.40	6.35	4.75	3.05	1.90	1.65	1.70	3.50	4.70
8	4.75	4.55	4.50	7.50	6.40	4.65	3.00	1.90	1.65	1.75	3.50	4.95
9	4.75	4.45	5.00	7.60	6.35	4.60	2.95	1.85	1.65	1.75	3.50	5.10
10	4.80	4.40	5.50	7.60	6.35	4.50	2.90	1.80	1.60	1.80	3.50	5.20
11	5.00	4.30	5.75	7.60	6.35	4.40	2.85	1.80	1.60	1.80	3.50	5.20
12	5.10	4.25	6.10	7.60	6.40	4.30	2.80	1.75	1.60	1.80	3.45	5.20
13	5.30	4.20	6.35	7.55	6.45	4.20	2.75	1.75	1.60	1.80	3.40	5.20
14	6.10	4.10	6.65	7.45	6.50	4.10	2.70	1.75	1.60	1.80	3.40	5.15
15	6.80	4.00	6.85	7.40	6.50	4.00	2.65	1.75	1.60	1.80	3.35	5.10
16	7.10	3.90	6.90	7.35	6.50	3.90	2.60	1.75	1.60	1.80	3.30	5.10
17	7.20	3.80	6.95	7.25	6.50	3.90	2.60	1.75	1.55	1.80	3.25	5.10
18	7.20	3.70	7.00	7.20	6.50	3.85	2.50	1.70	1.55	1.80	3.30	5.10
19	7.20	3.60	7.00	7.10	6.50	3.90	2.45	1.70	1.55	1.80	3.35	5.10
20	7.10	3.60	7.00	7.10	6.50	3.90	2.45	1.70	1.55	1.80	3.35	5.20
21	7.10	3.60	7.05	7.10	6.45	3.85	2.40	1.70	1.60	1.85	3.35	5.35
22	7.00	3.60	7.10	7.10	6.40	3.80	2.35	1.70	1.60	2.00	3.35	5.85
23	6.90	3.70	7.15	7.05	6.35	3.75	2.30	1.70	1.60	2.20	3.35	6.20
24	6.80	3.70	7.20	7.05	6.20	3.70	2.30	1.65	1.65	2.30	3.30	6.60
25	6.65	3.80	7.25	7.00	6.05	3.70	2.25	1.65	1.65	2.45	3.30	6.70
26	6.50	3.85	7.25	6.90	6.00	3.65	2.25	1.65	1.70	2.50	3.30	6.70
27	6.35	3.85	7.35	6.85	5.85	3.60	2.20	1.70	1.70	2.60	3.35	6.65
28	6.25	3.90	7.35	6.75	5.70	3.50	2.15	1.70	1.75	2.60	3.35	6.45
29	6.10	.....	7.35	6.60	5.60	3.45	2.10	1.70	1.75	2.65	3.40	6.30
30	5.85	.....	7.30	6.45	5.50	3.40	2.10	1.70	1.75	2.70	3.45	6.15
31	5.60	.....	7.25	.....	5.45	.....	2.05	1.70	.....	2.70	.....	6.00

LAKE CHELAN AT LAKESIDE, WASHINGTON.

This station is described in Water-Supply Paper No. 38, page 371. The gage was established by Capt. Charles Johnson on September 1, 1897, at the base of the rock pier on the lake shore north of his house, about a half mile from the steamboat landing. The bench mark is a United States Geological Survey iron post, with the elevation—1,121 feet above the sea level—stamped on the top. It is just 21 feet above the datum of the gage, so that to obtain the elevation of the surface of the lake above sea level 1,100 feet should be added to the rod readings. No records of the height of the lake were taken during 1900.

NACHES RIVER AT NORTH YAKIMA, WASHINGTON.

The original station on this river was established August 14, 1893, was abandoned in 1897, and another was established February 1, 1898. Measurements are made from the downstream side of the highway bridge about 300 feet above the Northern Pacific Railroad bridge. The river has considerable fall, and the water can easily be diverted by means of comparatively short canals. On this account it is of great value for irrigation and power purposes, and is the source of water supply and power for the Yakima Water, Light and Power Company. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 355; for 1898, Twentieth Annual Report, Part IV, page 503; for 1899, Twenty-first Annual Report, Part IV, page 426. During 1900 the following measurements were made by Sydney Arnold:

Discharge measurements of Naches River at North Yakima, Washington.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 27	6.80	2,000	June 4	6.85	1,905
May 8	8.10	4,914	July 17	5.70	670
May 24	7.00	1,988	August 1	5.45	494
May 29	6.85	1,955			

Daily gage height, in feet, of Naches River at North Yakima, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.20	6.60	6.20	a7.40	7.00	6.60	a6.10	5.50	5.20	5.30	6.00	6.60
2	7.10	6.50	6.20	7.50	7.30	6.60	6.00	5.50	a5.20	5.30	6.10	a6.65
3	7.00	6.50	6.20	7.80	7.60	a6.65	6.00	5.40	5.20	5.30	6.20	6.70
4	6.90	a6.45	a6.20	7.70	8.00	6.70	5.90	5.40	5.20	5.30	a6.25	7.10
5	6.80	6.40	6.20	7.60	8.00	6.90	5.90	5.35	5.20	5.30	6.30	7.90
6	6.60	6.40	6.20	7.60	8.00	7.40	5.90	5.30	5.20	5.30	6.20	8.20
7	a6.60	6.30	6.20	8.20	8.00	7.20	5.80	5.30	5.20	a5.30	6.10	8.00
8	6.60	6.30	6.40	a8.05	8.20	7.10	a5.75	5.30	5.20	5.30	6.20	7.80
9	6.60	6.20	6.50	7.90	8.10	7.10	5.70	5.30	a5.25	5.30	6.30	a7.60
10	6.50	6.20	6.70	7.80	8.00	a6.90	5.70	5.30	5.30	5.30	6.30	7.40
11	6.50	a6.35	a7.30	7.50	8.00	6.70	5.70	5.30	5.30	5.30	a6.25	7.20
12	6.50	6.50	7.90	7.40	8.00	6.70	5.70	5.75	5.30	5.20	6.20	6.90
13	9.70	6.40	7.90	7.40	7.80	6.70	5.60	5.20	5.30	5.20	6.20	6.90
14	a9.10	6.30	7.80	7.30	7.60	6.70	5.60	5.20	5.30	a5.20	6.20	6.80
15	8.50	6.20	7.70	a7.25	7.40	6.70	a5.55	5.20	5.30	5.20	6.30	6.80
16	8.10	6.10	7.60	7.20	7.40	6.70	5.50	5.20	a5.45	5.20	6.40	a6.80
17	7.90	6.10	7.50	7.20	7.30	a6.65	5.50	5.10	5.60	5.20	6.40	6.80
18	7.80	a6.10	a7.55	7.20	7.30	6.60	5.50	5.10	5.60	5.20	a6.40	6.70
19	7.70	6.10	7.60	7.40	7.20	6.60	5.40	5.10	5.50	5.30	6.40	6.60
20	7.60	6.10	7.60	7.30	7.20	7.10	5.40	5.10	5.50	5.30	6.40	6.90
21	a7.50	6.10	7.70	7.30	7.20	7.0	5.40	5.10	5.40	a6.00	6.40	8.40
22	7.40	6.20	7.70	a7.20	7.10	7.20	a5.50	5.10	5.40	6.70	6.30	8.10
23	7.30	6.40	7.70	7.10	7.00	6.90	5.60	5.20	a5.40	6.90	6.30	a7.85
24	7.20	6.40	7.60	7.00	7.00	a6.75	5.60	5.20	5.40	6.80	6.30	7.60
25	7.10	a6.35	a7.60	6.90	6.90	6.60	5.60	5.30	5.40	6.60	a6.40	7.40
26	7.00	6.30	7.60	6.90	7.10	6.50	5.60	5.40	5.40	6.40	6.50	7.20
27	6.90	6.30	7.50	6.80	7.05	6.40	5.50	5.50	5.40	6.20	6.50	7.10
28	a6.85	6.20	7.40	6.70	7.00	6.30	5.50	5.40	5.30	6.10	6.40	6.90
29	6.80	.....	7.20	a6.75	6.80	6.30	5.50	5.30	5.30	6.00	6.30	6.80
30	6.80	.....	7.20	6.80	6.70	6.20	5.50	5.20	5.30	6.00	6.30	a6.60
31	6.70	.....	7.30	.....	6.60	.....	.....	5.20	.....	5.90	.....	6.40

a Estimated.

YAKIMA RIVER AT UNION GAP, WASHINGTON.

This river has its source in Keechelus Lake, on the eastern slope of the Cascade Mountains, in Kittitas County, Washington. A short distance down it receives the waters of Kachess Lake, and 2½ miles above Clealum it receives the outlet of the last of the three large headwater lakes, namely Lake Clealum. The valley of the river is comparatively narrow until the vicinity of Ellensburg, where considerable irrigation is practiced, is reached. There it widens, and at the lower end of that valley it enters a canyon 20 miles long. After entering Yakima County it flows into Selah Valley, a plain 4 miles in length, at the lower end of which it passes through a narrow gap to enter Yakima Valley. This section is extensively irrigated, being served principally by canals from Naches River. Six miles below North Yakima the river passes through what is known as Union Gap, and then enters its lower valley—comprising the Parker and Sunnyside districts and the Yakima Indian Reservation—which extends to Kiona. Yakima River enters Columbia River 23 miles below this point, and just above the town of Pasco.

The gaging station at Union Gap was established August 14, 1893. It is 6 miles below North Yakima, about 1,000 feet below the highway bridge, and about 3 miles above the head gate of the Sunnyside canal. The gage rod is inclined, and is attached to a willow stump and to posts set in the ground. The bench mark is the highest point of a large rock mound 25 feet north of the gage and 10 feet east of the fence, and is at an elevation of 17.52 feet above gage datum. The equipment consists of cable, car, and tagged wire. The station is of value in determining the amount of water available for the extensive irrigable lands below. The results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 358; for 1897, Nineteenth Annual Report, Part IV, page 479; for 1898, Twentieth Annual Report, Part IV, page 500; for 1899, Twenty-first Annual Report, Part IV, page 427. During 1900 the following measurements of discharge were made by Sydney Arnold:

May 25: Gage height, 6.45 feet; discharge, 4,728 second-feet.
May 30: Gage height, 6.20 feet; discharge, 4,110 second-feet.
August 1: Gage height, 4.40 feet; discharge, 1,051 second-feet.
September 1: Gage height, 4.40 feet; discharge, 1,066 second-feet.

Daily gage height, in feet, of Yakima River at Union Gap, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.2	6.5	6.0	7.2	6.7	6.0	5.6	4.4	4.4	4.5	5.9	6.4
2	7.1	6.4	6.0	7.4	6.9	6.0	5.5	4.4	4.3	4.4	5.9	6.4
3	6.8	6.3	6.0	7.9	7.1	6.0	5.5	4.4	4.2	4.4	6.1	6.5
4	6.7	6.2	6.0	8.0	7.8	6.1	5.4	4.3	4.2	4.4	6.2	6.6
5	6.6	6.2	6.0	8.1	8.2	6.2	5.4	4.3	4.3	4.4	6.3	6.9
6	6.5	6.1	6.1	7.9	8.3	6.1	5.3	4.3	4.3	4.4	6.3	8.9
7	6.4	6.1	6.2	8.3	8.2	6.2	5.3	4.2	4.3	4.5	6.3	9.1
8	6.4	6.0	6.3	8.6	8.1	6.2	5.2	4.2	4.4	4.5	6.3	8.7
9	6.3	6.0	6.4	8.4	8.0	6.3	5.2	4.2	4.4	4.5	6.2	8.2
10	6.2	6.0	6.5	8.0	8.0	6.4	5.1	4.2	4.4	4.4	6.2	7.8
11	9.2	6.2	6.6	7.8	8.0	6.2	5.0	4.3	4.4	4.4	6.1	7.4
12	10.7	6.2	7.0	7.6	8.0	6.2	5.0	4.3	4.4	4.4	6.0	7.1
13	9.6	6.1	8.0	7.5	7.8	6.1	4.9	4.2	4.4	4.4	6.0	7.0
14	10.7	6.1	8.4	7.5	7.6	6.2	4.9	4.2	4.4	4.4	5.9	6.9
15	10.7	6.0	8.5	7.4	7.4	6.1	4.9	4.1	4.4	4.3	5.8	6.8
16	9.6	5.9	8.3	7.4	7.3	6.1	4.8	4.1	4.5	4.3	5.7	6.8
17	9.0	5.9	8.1	7.3	7.3	6.1	4.8	4.1	4.5	4.3	5.7	6.9
18	8.5	5.9	8.0	7.4	7.1	6.1	4.8	4.1	4.5	4.3	5.9	6.8
19	8.2	5.8	8.1	7.4	7.0	6.1	4.7	4.1	4.5	4.5	6.0	6.7
20	8.1	5.9	8.2	7.3	6.9	6.2	4.7	4.1	4.4	4.6	6.0	6.6
21	8.0	5.9	8.3	7.3	6.8	6.3	4.7	4.1	4.4	5.1	5.9	7.8
22	7.8	6.2	8.2	7.3	6.8	6.5	4.7	4.0	4.4	6.2	5.7	8.3
23	7.4	6.2	8.2	7.1	6.7	6.4	4.7	4.0	4.5	7.1	5.8	8.0
24	7.2	6.2	8.1	6.9	6.6	6.2	4.6	4.0	4.6	6.9	5.8	7.6
25	7.1	6.2	7.9	6.8	6.5	6.1	4.6	4.0	4.7	6.8	5.9	7.4
26	7.0	6.2	7.8	6.6	6.5	6.1	4.6	4.2	4.7	6.6	5.9	7.2
27	6.9	6.2	7.6	6.5	6.5	6.0	4.6	4.3	4.6	6.4	6.0	7.0
28	6.7	6.1	7.5	6.5	6.5	5.9	4.5	4.5	4.6	6.2	6.0	6.6
29	6.6	.....	7.4	6.6	6.4	5.8	4.5	4.5	4.6	6.1	5.9	6.4
30	6.6	.....	7.3	6.7	6.2	5.7	4.5	4.5	4.5	6.0	5.9	6.4
31	6.5	.....	7.3	.....	6.1	.....	4.5	4.4	.....	5.9	.....	6.3

YAKIMA RIVER AT KIONA, WASHINGTON.

This station, established August 20, 1895, is on the highway bridge at Kiona. It is described in Water-Supply Paper No. 38, page 375. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 359; for 1897, Nineteenth Annual Report, Part IV, page 484; for 1898, Twentieth Annual Report, Part IV, page 502; for 1899, Twenty-first Annual Report, Part IV, page 428. During 1900 the following discharge measurements were made by Sydney Arnold:

May 5: Gage height, 8.56 feet; discharge, 8,312 second-feet.
May 28: Gage height, 6.70 feet; discharge, 4,450 second-feet.
June 7: Gage height, 6.63 feet; discharge, 4,351 second-feet.
June 29: Gage height, 5.60 feet; discharge, 2,987 second-feet.

Daily gage height, in feet, of Yakima River at Kiona, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.50	6.94	6.43	7.96	7.32	6.14	5.55	3.63	3.59	4.14	5.50	7.24
2	8.02	6.78	6.37	8.03	7.70	6.00	5.43	3.63	3.59	4.20	5.63	7.55
3	7.88	6.68	6.29	8.70	7.96	6.00	5.30	3.63	3.56	4.15	5.75	7.70
4	7.51	6.57	6.33	9.06	8.30	6.10	5.18	3.63	3.55	4.13	5.90	8.00
5	7.28	6.54	6.45	9.00	8.56	6.20	5.05	3.56	3.58	4.10	6.03	8.25
6	7.14	6.38	6.41	8.92	8.60	6.33	4.94	3.53	3.60	4.06	6.20	10.20
7	7.00	6.39	6.38	8.89	8.73	6.41	4.86	3.50	3.62	4.05	6.35	10.98
8	6.91	6.40	6.35	9.55	8.83	6.48	4.80	3.43	3.62	4.03	6.46	10.90
9	6.89	6.32	6.99	9.70	8.92	6.55	4.80	3.73	3.62	4.05	6.55	10.70
10	6.80	6.28	7.09	9.43	8.90	6.50	4.78	3.40	3.63	4.02	6.64	10.25
11	6.72	6.27	7.36	9.03	8.70	6.53	4.70	3.35	3.60	4.00	6.70	9.45
12	6.70	6.50	8.10	8.60	8.65	6.46	4.63	3.40	3.54	3.95	6.76	9.10
13	7.16	6.71	9.27	8.36	8.55	6.30	4.50	3.45	3.49	3.95	6.76	8.75
14	11.50	6.60	9.75	8.35	8.32	6.20	4.50	3.30	3.55	4.04	6.80	8.40
15	12.24	6.56	9.80	8.36	8.13	6.13	4.48	3.28	3.60	4.10	6.86	8.25
16	11.49	6.26	9.50	8.22	7.82	6.00	4.48	3.26	3.61	4.18	6.95	8.20
17	10.52	5.30	9.35	8.07	7.70	5.95	4.40	3.26	3.62	4.26	6.87	8.15
18	9.80	5.90	9.20	8.00	7.70	5.98	4.35	3.20	3.87	4.40	6.80	8.10
19	9.49	6.24	9.12	7.95	7.50	6.00	4.25	3.18	3.80	4.52	6.73	8.16
20	9.30	6.34	9.20	8.03	7.20	6.00	4.24	3.25	3.76	4.55	6.75	8.20
21	9.12	6.33	9.25	8.12	7.10	6.10	4.21	3.15	3.71	4.60	6.80	8.20
22	8.94	6.42	9.20	7.93	7.18	6.05	4.16	3.11	3.63	4.72	6.80	10.20
23	8.68	6.84	9.15	7.70	7.05	6.00	4.10	3.06	3.75	4.78	6.85	10.40
24	8.51	6.86	9.20	7.60	6.85	6.00	4.03	3.05	3.82	4.85	6.85	10.30
25	8.10	6.78	9.08	7.30	6.80	6.00	3.95	3.10	3.90	4.92	6.85	10.05
26	7.84	6.70	8.80	7.25	6.74	6.08	3.95	3.20	3.92	5.02	6.81	9.32
27	7.57	6.62	8.90	7.00	6.65	5.98	3.90	3.25	3.98	5.16	6.90	9.00
28	7.36	6.48	8.73	6.95	6.56	5.80	3.88	3.65	4.05	5.20	7.08	8.75
29	7.16	.....	8.50	6.80	6.40	5.63	3.88	3.65	4.10	5.26	7.06	8.32
30	7.05	.....	8.20	6.93	6.33	5.55	3.85	3.68	4.14	5.32	6.96	8.20
31	7.05	.....	8.10	.....	6.25	.....	3.78	3.64	.....	5.40	.....	8.00

MISCELLANEOUS DISCHARGE MEASUREMENTS IN YAKIMA COUNTY, WASHINGTON.

During the year Mr. Sydney Arnold made miscellaneous discharge measurements of a number of streams in Yakima County, Washington, as described in the following table:

Miscellaneous discharge measurements in Yakima County, Washington.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
May 7	Wenas Creek	Sec. 33, T. 16 N., R. 17 E.	40
Do	do	Sec. 12, T. 15 N., R. 17 E.	35
July 28	Cowiche Creek	Sec. 36, T. 14 N., R. 16 E.	1
August 15	Atanum River, North Fork	Sec. 18, T. 12 N., R. 16 E.	17
August 24	do	Sec. 12, T. 12 N., R. 15 E.	24
Do	Atanum River, South Fork	Sec. 32, T. 12 N., R. 15 E.	9
August 18	Klickitat River, Gold Fork	Near mouth	48
Do	Klickitat River, Diamond Fork	do	114

PALOUSE RIVER NEAR HOOPER, WASHINGTON.

This station, established September 9, 1897, is opposite the water tank of the railroad company near Hooper. It is described in Water-Supply Paper No. 38, page 360. The discharge measurements are made from a car suspended from a light steel cable about 50 feet above the gage. Results of measurements will be found as follows: For 1897, Nineteenth Annual Report, Part IV, page 460; for 1898, Twentieth Annual Report, Part IV, page 489; for 1899, Twenty-first

Annual Report, Part IV, page 414. During 1900 one discharge measurement was made by Sydney Arnold, as follows:

June 6: Gage height, 2.95 feet; discharge, 233 second-feet.

Daily gage height, in feet, of Palouse River near Hooper, Washington, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.80	3.70	3.30	1.90	1.55	1.40	1.85	2.60	3.00
2	4.50	3.65	3.25	1.90	1.55	1.40	1.40	2.50	3.20
3	4.40	3.60	3.20	1.90	1.55	1.35	1.50	2.45	3.40
4	4.30	3.50	3.10	1.90	1.55	1.35	1.70	2.40	3.40
5	4.45	3.45	3.00	1.90	1.50	1.30	1.75	2.80	3.70
6	4.70	3.40	2.90	1.90	1.50	1.30	1.80	3.20	4.10
7	4.60	3.40	2.80	1.80	1.50	1.35	1.90	3.10	4.30
8	5.00	3.50	2.80	1.75	1.50	1.40	2.00	3.00	4.50
9	4.70	3.40	2.80	1.75	1.45	1.45	2.10	1.80	4.60
10	4.60	3.35	2.70	1.75	1.45	1.45	2.15	1.70	4.50
11	4.50	3.35	2.60	1.70	1.45	1.40	2.15	1.60	4.30
12	4.20	3.30	2.55	1.70	1.45	1.40	2.15	1.50	4.10
13	4.10	3.25	2.50	1.70	1.45	1.40	2.10	1.50	3.90
14	3.90	3.20	2.45	1.70	1.45	1.40	2.10	1.40	3.70
15	4.00	3.55	2.45	1.70	1.40	1.40	2.10	1.40	3.60
16	4.30	3.70	2.40	1.70	1.40	1.45	2.10	1.30	3.80
17	4.00	3.90	2.35	1.70	1.40	1.45	2.10	1.40	3.90
18	3.80	4.30	2.30	1.70	1.40	1.45	2.15	1.45	4.20
19	3.70	4.60	2.30	1.70	1.40	1.45	2.15	1.50	4.60
20	3.50	4.20	2.30	1.70	1.40	1.45	2.10	1.40	4.95
21	3.50	3.90	2.30	1.65	1.40	1.45	2.30	1.30	5.30
22	3.50	3.70	2.45	1.65	1.40	1.45	2.35	1.40	5.50
23	3.35	3.60	2.40	1.65	1.40	1.50	2.50	1.50	5.70
24	3.20	3.60	2.30	1.65	1.40	1.50	2.60	1.70	6.40
25	3.10	3.65	2.10	1.65	1.40	1.35	2.70	1.70	5.90
26	3.00	3.60	2.10	1.65	1.40	1.30	2.75	1.80	5.60
27	3.25	3.50	2.05	1.60	1.40	1.25	2.80	1.90	5.20
28	3.30	3.40	2.00	1.55	1.40	1.25	2.80	2.60	4.90
29	3.30	3.50	2.00	1.55	1.40	1.25	2.80	3.40	4.60
30	3.40	3.50	1.90	1.55	1.40	1.30	2.70	3.10	4.00
31	.....	3.40	.....	1.55	1.40	.....	2.60	.....	3.80

UMATILLA RIVER AT GIBBON, OREGON.

This station, established July 26, 1896, is a half mile west of the railroad station. It is described in Water-Supply Paper No. 38, page 376. Results of measurements will be found as follows: For 1896, Eighteenth Annual Report, Part IV, page 361; for 1897, Nineteenth Annual Report, Part IV, page 493; for 1898, Twentieth Annual Report, Part IV, page 515. There were no measurements of discharge made at this station in 1899 and 1900.

Daily gage height, in feet, of Umatilla River at Gibbon, Oregon, for 1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.70	1.00	0.50	0.30	0.50	0.65	2.00	2.40
2	.....	2.90	.90	.45	.30	.50	.70	2.00	2.50
3	.....	2.90	.85	.45	.30	.50	.70	2.05	2.70
4	.....	2.90	.80	.45	.30	.45	.75	2.10	3.00
5	.....	3.00	.80	.45	.30	.45	1.20	2.00	3.50
6	.....	2.85	.75	.45	.30	.45	1.10	1.90	3.10
7	.....	2.70	.75	.45	.30	.45	1.00	1.85	2.85
8	.....	2.40	.70	.45	.40	.45	1.00	1.80	2.70
9	.....	2.30	.70	.40	.50	.45	1.00	1.70	2.50
10	.....	2.25	.65	.40	.40	.40	.90	1.65	2.35
11	.....	2.30	.65	.40	.40	.40	.85	1.55	2.25
12	.....	2.20	.65	.40	.35	.40	.85	1.50	2.05
13	.....	2.10	.65	.40	.35	.40	.80	1.40	1.95
14	.....	2.00	.65	.35	.35	.40	.80	1.35	1.90
15	3.90	1.95	.70	.35	.30	.45	.80	1.25	1.90
16	3.90	2.35	.70	.35	.30	.45	.75	1.25	1.95
17	3.80	2.20	.65	.35	.30	.45	.75	1.20	1.95
18	3.60	2.10	.65	.35	.30	.50	.75	1.20	1.95
19	3.45	1.95	.65	.35	.30	.50	.80	1.20	2.00
20	3.35	1.85	.65	.35	.30	.50	.85	1.25	2.10
21	3.20	1.75	.65	.35	.50	.50	.90	1.25	2.95
22	3.05	1.65	.60	.35	.40	.55	.90	1.30	2.85
23	2.90	1.60	.60	.35	.40	.55	1.00	1.30	2.80
24	2.80	1.55	.55	.30	.90	1.00	1.05	1.35	2.70
25	2.65	1.45	.55	.30	1.50	1.00	1.15	1.80	2.60
26	2.55	1.45	.55	.30	1.00	.95	1.20	1.80	2.40
27	2.45	1.35	.50	.30	.80	.85	1.20	1.75	2.30
28	2.35	1.25	.50	.30	.50	.85	1.30	1.65	2.15
29	2.25	1.15	.50	.30	.50	.75	1.40	1.65	1.95
30	2.45	1.10	.50	.30	.50	.70	1.60	2.10	1.80
31	.....	1.05	.....	.30	.50	.....	2.00	.....	1.80

DESCHUTES RIVER AT MORO, OREGON.

This station was established October 19, 1897, being 3 miles above what is known as the Free Bridge, and 16 miles east of The Dalles. It is described in Water-Supply Paper No. 38, page 377. Results of measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 433. The station was discontinued December 31, 1899.

HOOD RIVER AT TUCKER, OREGON.

This station, established October 20, 1897, is 5 miles south of Hood-river, Oregon. It is described in Water-Supply Paper No. 38, page 380. Results of measurements for 1898 and 1899 will be found in the Twenty-first Annual Report, Part IV, page 435. The station was discontinued December 31, 1899.

WHITE RIVER NEAR BUCKLEY, WASHINGTON.

This station, established April 22, 1899, is at the new highway bridge 500 feet above the Northern Pacific Railroad bridge and a half mile north of the town of Buckley. It is described in Water-Supply Paper No. 38, page 381. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 437. Dur-

ing 1900 the following measurements of discharge were made by Sydney Arnold:

May 22: Gage height, 1.73 feet; discharge, 1,826 second-feet.
June 1: Gage height, 1.55 feet; discharge, 1,560 second-feet.
June 28: Gage height, 1.88 feet; discharge, 2,156 second-feet.

Daily gage height, in feet, of White River near Buckley, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	1.30	1.55	1.70	1.60	1.55	1.60	1.30	0.90	0.55	1.75	2.45
2	2.10	1.25	1.55	2.05	1.75	1.55	1.55	1.20	.85	.55	2.80	2.15
3	2.05	1.30	1.55	2.05	1.90	1.60	1.55	1.15	.85	.50	2.20	2.75
4	1.75	1.25	1.50	1.95	2.15	1.60	1.60	1.10	.85	.50	1.75	3.50
5	1.75	1.25	1.50	1.80	2.50	2.15	1.70	1.10	.80	.50	1.60	4.33
6	1.75	1.35	1.45	2.05	2.25	1.90	1.90	1.05	.80	.50	1.45	3.75
7	1.70	1.30	1.60	2.40	2.15	1.80	1.80	1.00	.80	.45	1.35	2.75
8	1.75	1.30	1.80	2.10	2.40	1.90	1.70	1.00	1.00	.45	1.30	2.25
9	1.65	1.40	1.95	1.95	2.35	1.75	1.60	1.00	1.00	.45	1.30	1.95
10	2.00	1.55	2.15	1.80	2.35	1.65	1.55	.95	.90	.60	1.20	1.75
11	2.25	2.30	3.20	1.70	2.30	1.60	1.55	.95	.90	.55	1.10	1.65
12	5.50	2.05	3.30	1.60	2.15	1.60	1.50	.95	.85	.55	1.10	1.60
13	5.20	1.75	2.75	1.75	2.05	1.70	1.50	1.05	.85	.55	1.10	1.40
14	3.38	1.50	2.40	1.70	1.95	1.75	1.40	1.05	.75	.65	1.10	1.65
15	2.90	1.50	2.30	1.95	1.80	1.75	1.35	1.00	.70	.60	1.05	1.60
16	2.70	1.40	2.15	1.95	2.20	1.65	1.35	.90	.65	.55	1.05	1.85
17	2.55	1.35	2.05	1.85	2.05	1.60	1.40	.85	.60	.55	1.25	1.60
18	2.50	1.35	2.05	1.75	1.85	1.55	1.30	.85	.55	.75	1.30	1.50
19	2.30	1.30	2.00	1.75	1.80	1.90	1.30	.85	.55	1.00	1.15	1.45
20	2.25	1.25	1.95	1.70	1.80	2.60	1.30	1.00	.55	1.35	.95	2.50
21	2.10	2.18	1.95	1.60	1.80	3.10	1.40	1.00	.55	2.38	.70	2.90
22	1.85	2.25	1.95	1.55	1.70	2.70	1.40	.90	.55	2.60	1.00	2.45
23	1.70	2.05	1.80	1.45	1.60	2.35	1.35	1.05	1.25	1.90	1.10	2.05
24	1.63	1.80	1.65	1.40	1.55	2.10	1.40	1.20	.95	1.70	1.10	1.95
25	1.55	1.70	1.75	1.40	1.55	2.20	1.50	2.58	.85	2.75	1.85	1.85
26	1.55	1.65	1.70	1.35	2.10	2.35	1.40	1.50	.75	2.10	1.95	1.80
27	1.50	1.60	1.60	1.30	1.85	2.10	1.30	1.25	.60	1.70	1.65	1.65
28	1.60	1.60	1.50	1.25	1.85	1.85	1.20	1.15	.60	1.50	1.55	1.60
29	1.50	.....	1.50	1.25	1.75	1.75	1.15	1.00	.60	1.35	1.75	1.60
30	1.35	.....	1.55	1.25	1.65	1.70	1.20	.90	.60	1.35	2.00	1.45
31	1.35	.....	1.55	.....	1.60	.....	1.30	.90	.....	1.95	.....	1.30

DUNGENESS RIVER AT DUNGENESS, WASHINGTON.

This station as originally established, July 5, 1897, was 9 miles above the mouth of the river. On July 29, 1898, it was moved to the bridge 8½ miles downstream, or near the mouth. Owing to the formation of a sandbar under the rod, the gage was moved July 3, 1900, to another part of the bridge. In its present location the zero end of the rod is exactly opposite the center of the third vertical iron brace from the northwest end of the bridge. The length of the wire gage cable is 24 feet and 11 inches. The station is described in Water-Supply Paper No. 38, page 383. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 438. During 1900 the following measurements of discharge were made by W. J. Ware:

Discharge measurements of Dungeness River at Dungeness, Washington.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
February 22	3.80	324	August 31	3.40	249
March 22	4.20	710	September 24	3.55	274
April 30	4.00	456	October 20	3.95	418
June 2	4.30	483	November 30	3.90	450
July 4	4.50	566	December 24	4.95	880

Daily gage height, in feet, of Dungeness River at Dungeness, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	3.90	3.50	4.45	4.10	4.30	4.50	4.25	3.50	3.15	3.60	4.30
2	4.35	3.85	3.50	4.50	4.20	4.30	4.35	4.20	3.50	3.15	3.55	4.50
3	4.20	3.80	3.45	5.00	4.30	4.40	4.50	4.20	3.50	3.10	3.50	4.80
4	4.10	3.80	3.45	5.50	4.50	5.00	4.60	4.20	3.45	3.10	3.50	5.05
5	4.00	3.75	3.40	5.90	4.70	5.60	4.80	4.15	3.45	3.05	3.45	5.25
6	3.90	3.70	3.35	5.85	5.00	4.40	4.65	4.10	3.40	3.00	3.45	5.25
7	4.50	3.60	3.30	5.80	5.10	4.50	4.50	4.00	3.40	3.05	3.40	5.25
8	5.10	3.55	4.20	4.80	5.25	4.55	4.45	3.90	3.40	3.00	3.40	5.30
9	5.15	3.60	6.60	4.75	5.25	4.60	4.40	3.85	3.35	3.00	3.40	5.50
10	5.20	3.60	9.05	4.75	5.10	4.65	4.40	3.80	3.35	3.05	3.40	5.80
11	5.25	3.60	11.00	4.70	5.00	4.70	4.40	3.75	3.30	3.05	3.45	6.00
12	5.25	3.60	9.10	4.65	4.90	4.80	4.35	3.75	3.30	3.10	3.45	6.20
13	5.35	3.55	7.30	4.60	4.80	4.80	4.30	3.70	3.30	3.10	3.50	6.40
14	5.50	3.55	6.20	4.50	4.70	4.90	4.25	3.70	3.25	3.10	3.50	6.60
15	5.20	3.60	5.00	4.40	4.65	4.90	4.30	3.65	3.30	3.05	3.45	7.00
16	5.00	3.60	4.80	4.30	4.60	5.05	4.30	3.60	3.25	3.00	3.40	7.20
17	4.50	3.55	4.70	4.25	4.60	5.20	4.35	3.65	3.20	3.10	3.30	6.80
18	4.40	3.55	4.60	4.20	4.55	5.50	4.40	3.60	3.15	3.20	3.30	6.60
19	4.30	3.55	4.50	4.20	4.55	6.00	4.40	3.60	3.10	4.00	3.35	5.70
20	4.25	3.60	4.45	4.15	4.50	7.10	4.45	3.60	3.20	4.20	3.35	11.30
21	4.25	3.60	4.40	4.10	4.45	6.20	4.45	3.65	3.30	4.30	3.40	7.30
22	4.25	3.65	4.30	4.00	4.40	5.45	4.50	3.65	3.40	4.25	3.40	5.70
23	4.25	3.65	4.20	3.95	4.30	5.30	4.50	3.70	3.50	4.20	3.45	5.20
24	4.20	3.70	4.10	3.90	4.20	5.20	4.40	3.70	3.55	4.15	3.50	4.90
25	4.20	3.65	4.00	3.90	4.10	5.10	4.35	3.80	3.50	4.10	3.60	4.80
26	4.20	3.65	3.95	3.95	4.05	5.00	4.25	3.75	3.45	4.00	3.70	4.65
27	4.15	3.60	3.90	3.95	4.00	4.95	4.20	3.75	3.35	3.90	3.80	4.50
28	4.10	3.55	3.90	4.00	4.05	4.90	4.20	3.60	3.30	3.85	3.90	4.05
29	4.10	.....	4.15	4.00	4.10	4.80	4.20	3.60	3.20	3.80	4.00	4.00
30	4.05	.....	4.20	4.00	4.15	4.75	4.20	3.55	3.20	3.70	4.15	3.90
31	4.00	.....	4.30	.....	4.25	.....	4.20	3.50	.....	3.65	.....	3.85

ELWHA RIVER AT McDONALD, WASHINGTON.

This station, established October 8, 1897, is at the new county bridge 9 miles southwest of Port Angeles. It is described in Water-Supply Paper No. 38, page 384. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 439. During 1900 the following measurements of discharge were made by W. J. Ware:

Discharge measurements of Elwha River at McDonald, Washington.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
March 15	4.40	3,277	July 20	3.07	1,207
April 28	2.74	1,109	August 22	2.33	645
May 31	3.05	1,261	October 30	3.30	1,471
June 27	3.80	1,677	November 29	3.46	1,807

Daily gage height, in feet, of Elwha River at McDonald, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.58	2.81	2.59	3.15	3.06	3.08	3.41	3.06	2.29	1.90	3.19	4.02
2	3.40	3.02	2.40	3.15	3.50	3.14	2.80	3.10	2.22	1.74	3.20	4.26
3	3.29	3.26	2.33	3.37	3.74	3.33	2.46	2.95	2.21	1.76	3.18	4.80
4	3.20	2.78	2.30	3.30	3.87	4.10	3.53	2.60	2.16	1.85	3.09	5.67
5	4.05	2.75	2.25	3.28	3.96	5.05	3.50	2.76	2.07	1.72	2.96	6.01
6	3.90	2.70	2.28	6.66	3.90	3.90	3.15	2.66	2.22	1.69	2.64	5.02
7	5.30	2.72	2.54	5.20	4.12	3.76	3.14	2.66	2.28	1.55	2.74	4.20
8	5.35	2.60	3.33	4.19	4.15	3.65	3.09	2.57	2.40	1.48	3.15	3.90
9	5.38	2.55	5.54	3.95	3.80	3.59	3.08	2.57	2.33	1.50	2.86	3.60
10	4.17	2.52	7.90	3.80	3.71	3.65	3.04	2.68	2.21	1.72	2.70	3.58
11	3.87	2.35	11.10	3.55	3.80	3.60	3.14	2.56	2.17	1.88	2.65	3.34
12	6.67	2.32	6.50	3.50	3.82	3.45	3.43	2.63	2.05	1.81	2.70	4.22
13	5.60	2.25	5.15	3.39	3.55	3.64	3.05	2.70	1.97	1.79	2.88	4.24
14	4.40	2.19	4.66	3.36	3.30	4.00	2.94	2.75	1.95	2.65	2.90	5.05
15	4.15	2.19	4.40	3.20	3.28	4.10	3.04	2.74	2.02	2.03	2.95	4.84
16	3.92	2.20	4.42	3.18	3.89	4.16	3.03	2.82	2.00	1.94	3.56	7.80
17	3.90	2.23	4.38	3.19	3.53	3.69	3.00	2.80	1.88	2.03	4.65	5.65
18	3.86	2.26	4.12	3.36	3.45	3.63	2.98	2.82	1.85	3.02	3.60	5.20
19	3.70	2.50	3.95	3.35	3.39	5.50	2.95	2.69	2.08	3.23	3.34	6.55
20	3.50	2.60	3.80	3.12	3.20	7.75	3.07	2.56	2.17	2.98	2.95	9.90
21	3.40	3.20	3.78	3.09	3.00	5.54	3.17	2.55	2.12	5.67	2.87	7.20
22	3.59	3.34	3.75	2.90	2.92	4.82	3.22	2.33	2.42	5.55	3.36	6.22
23	4.15	2.60	3.72	2.84	2.98	4.40	3.42	3.10	2.95	3.55	2.90	5.22
24	3.58	2.48	3.69	2.85	3.63	4.33	3.22	2.50	2.51	3.03	3.04	4.88
25	3.48	2.30	3.79	2.83	3.75	4.18	3.05	3.15	2.05	5.53	5.40	5.08
26	3.27	2.60	3.90	2.80	4.20	3.98	2.96	2.44	1.96	3.40	4.38	4.35
27	2.98	2.61	3.42	2.76	3.62	3.80	2.80	2.42	1.92	3.14	3.45	4.08
28	2.97	2.70	3.25	2.74	3.40	3.71	2.72	2.12	1.89	3.21	3.90	3.90
29	2.88	.....	3.19	2.68	3.25	3.64	2.77	2.23	1.88	3.24	3.46	3.73
30	2.80	.....	3.16	2.63	3.09	3.59	2.45	2.32	1.88	3.30	4.34	3.47
31	2.81	.....	3.17	.....	3.05	.....	2.72	2.30	.....	3.40	.....	3.34

CALOWA RIVER NEAR FORKS, WASHINGTON.

This station, established November 12, 1897, is at the county highway bridge in the southwestern part of Clallam County, near Forks, Washington. It is described in Water-Supply Paper No. 38, page 386. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 441. During 1900 the following measurements of discharge were made by W. J. Ware:

March 2: Gage height, 2.85 feet; discharge, 1,234 second-feet.
May 27: Gage height, 3.50 feet; discharge, 1,608 second-feet.
July 26: Gage height, 1.20 feet; discharge, 295 second-feet.
December 15: Gage height, 6.70 feet; discharge, 4,496 second-feet.

Daily gage height, in feet, of Calowa River near Forks, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.85	2.05	3.00	1.65	0.60	1.40	1.85	0.40	0.02	0.00	5.20	4.85
2	3.20	2.70	2.85	1.65	.65	1.20	1.80	.40	.02	.05	5.40	4.85
3	3.85	2.25	2.60	1.60	.65	1.20	1.60	.45	.02	.00	5.60	4.25
4	4.00	2.25	2.45	1.65	.65	4.05	1.65	.45	.03	—.05	5.05	4.40
5	5.60	2.20	2.20	2.25	.80	4.70	1.80	.45	.03	—.05	5.25	4.45
6	9.20	2.05	4.00	3.45	1.25	3.20	1.60	.40	.03	.00	5.20	4.60
7	7.85	3.05	5.40	4.65	1.40	2.80	1.40	.40	.03	—.05	4.00	4.65
8	6.30	2.70	4.60	3.85	1.05	2.20	1.40	.25	.03	—.05	3.05	4.80
9	5.45	3.05	14.80	3.20	1.85	2.00	1.45	.25	.03	—.05	2.20	4.20
10	5.85	3.65	14.40	2.65	1.80	1.65	1.25	.20	.03	.00	2.30	4.40
11	5.25	3.20	13.40	2.45	1.60	1.60	1.80	.20	.03	—.05	2.25	4.00
12	10.20	3.05	7.00	2.40	1.65	1.45	1.40	.20	.03	—.05	2.05	4.20
13	7.45	2.40	4.65	2.05	1.65	1.25	1.65	.20	.03	1.00	2.05	4.40
14	5.20	2.25	3.85	2.00	1.60	1.20	1.45	.20	.02	3.00	2.20	6.25
15	4.25	2.20	3.45	1.85	2.00	1.05	1.40	.05	.02	2.00	2.40	7.05
16	5.00	2.05	3.45	1.80	2.00	1.05	1.25	.05	—.30	.65	2.45	10.30
17	4.45	3.60	2.60	1.60	1.80	1.00	1.20	.05	—.40	.60	2.46	7.40
18	4.85	3.85	2.40	1.65	1.80	1.20	1.05	.05	—.40	4.45	2.25	5.45
19	4.85	4.00	2.20	1.45	1.60	3.45	1.00	.05	—.05	3.25	2.40	5.00
20	4.65	4.20	2.05	1.40	2.25	8.80	1.00	.05	—.05	3.00	2.45	4.85
21	5.00	6.45	2.05	1.25	1.80	5.45	.85	.05	.00	10.00	2.60	5.45
22	5.60	7.15	2.00	1.25	1.25	3.80	.80	.00	1.00	6.15	2.65	8.50
23	6.40	7.00	2.80	1.20	1.45	3.20	1.80	.05	1.05	5.45	3.00	8.00
24	5.00	6.45	2.60	1.05	3.50	2.80	1.65	.20	.25	7.80	4.25	7.20
25	4.00	4.45	2.60	1.05	.....	2.25	1.25	1.45	.45	6.50	13.80	6.30
26	3.40	3.05	2.60	1.00	4.20	2.00	1.20	.60	.40	5.80	7.15	5.00
27	3.00	3.05	2.25	1.00	3.50	1.85	1.65	1.05	.25	5.00	6.25	4.25
28	3.45	3.20	2.20	1.85	2.85	1.80	.65	.65	.20	6.00	6.00	3.80
29	2.45	.....	2.05	.80	2.20	1.80	.45	.30	.05	7.15	5.80	4.00
30	2.25	.....	2.00	.65	1.85	1.85	.45	.09	.00	6.30	5.45	3.00
31	2.20	.....	1.80	.....	1.60	.....	.45	.05	.....	5.20	.....	2.80

SOLEDUCK RIVER NEAR QUILLAYUTE, WASHINGTON.

This station was established November 13, 1897, at the county highway bridge 9 miles northeast of Lapush, near Quillayute. On March 31, 1900, it was discontinued temporarily, on account of the destruction of the bridge to make room for a new one. The new bridge was completed on December 23, 1900, and observations of river heights were resumed on that date. The length of the cable of the new gage is 45 feet. The distance from the inside of the pulley wheel to the end of the rod is 49 inches. The station is described in Water-Supply Paper No. 38, page 386. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 443. During 1900 the following measurements of discharge were made by W. J. Ware:

March 2: Gage height, 4.40 feet; discharge, 1,321 second-feet.
July 25: Discharge, 550 second-feet.
December 14: Gage height, 8.70 feet; discharge, 5,964 second-feet.

The measurement on July 25 was made 6 miles above the station.

Daily gage height, in feet, of Soleduck River near Quillayute, Washington, for 1900.

Day.	Jan.	Feb.	Mar.	Dec.	Day.	Jan.	Feb.	Mar.	Dec.
1	5.45	4.00	4.45	.....	17	5.70	4.10	5.40	.....
2	5.20	4.10	4.40	.....	18	5.80	4.10	5.10	.....
3	5.10	4.20	4.30	.....	19	5.65	4.15	4.95	.....
4	4.95	4.10	4.10	.....	20	5.50	4.60	4.70	.....
5	4.70	3.95	3.90	.....	21	5.60	5.20	4.50	.....
6	6.40	4.15	3.80	.....	22	6.25	6.40	4.40	.....
7	6.90	4.25	4.90	.....	23	7.10	5.80	4.35	9.70
8	8.10	4.20	6.50	.....	24	6.45	5.10	4.20	8.30
9	7.50	4.40	9.60	.....	25	5.80	4.90	4.20	7.60
10	7.00	4.65	12.80	.....	26	5.20	4.65	4.15	8.10
11	6.20	4.80	13.60	.....	27	5.10	4.40	4.10	7.40
12	7.50	4.60	10.40	.....	28	4.85	4.50	4.10	6.85
13	8.40	4.20	7.50	.....	29	4.55	.....	4.00	6.60
14	7.10	4.10	6.85	8.70	30	4.20	.....	3.95	6.25
15	6.50	3.90	5.90	.....	31	4.10	.....	3.80	6.00
16	5.80	3.95	5.65	.....					

NOTE.—No record from April 1 to December 22; new bridge being erected.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN NORTHWESTERN WASHINGTON.

During the year William J. Ware made miscellaneous discharge measurements of a number of streams in northwestern Washington, as follows:

Miscellaneous discharge measurements in northwestern Washington.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
September 10	Morse River	Near Port Angeles	51
March 15	Little River	Near McDonald	174
May 31	do	do	68
June 27	do	do	54
July 20	do	do	28
August 22	do	do	20
October 30	do	do	52
December 17	Pysht River	Nine miles above mouth	262
July 30	Clallam River	Four miles above mouth	8
December 17	do	Two and one-half miles above mouth.	335

SACRAMENTO RIVER AT JELLYS FERRY, CALIFORNIA.

This station, established April 30, 1895, is 12 miles above the town of Redbluff, at the crossing of the county bridge at Jellys Ferry. It is described in Water-Supply Paper No. 38, page 387. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 446. During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

February 17: Gage height, 6.80 feet; discharge, 8,374 second-feet.
April 29: Gage height, 7.10 feet; discharge, 9,586 second-feet.
May 29: Gage height, 6.40 feet; discharge, 7,173 second-feet.
September 20: Gage height, 5 feet; discharge, 4,105 second-feet.
December 18: Gage height, 10 feet; discharge, 18,361 second-feet.

Daily gage height, in feet, of Sacramento River at Jellys Ferry, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.5	7.4	8.1	7.7	7.2	6.1	5.4	4.9	4.9	4.9	5.9	6.9
2	25.0	7.4	8.0	9.0	7.2	6.1	5.4	4.9	4.9	4.9	5 8	6.8
3	31.1	7.4	8.6	9.9	7.3	6.0	5.4	4.9	4.9	5.9	5.6	6.6
4	18.5	8.1	9.8	8.5	7.2	6.0	5.3	4.9	4.8	6.9	5.6	6.5
5	17.0	7.6	10.2	8.1	10.7	5.9	5.3	4.9	5.6	11.2	5.6	6.4
6	19.0	7.5	11.0	7.9	8.8	5.9	5.3	4.9	5.2	6.7	5.5	6.3
7	19.0	7.4	15.7	8.6	8.3	5.8	5.3	4.9	5.1	5.6	5.5	6.3
8	18.5	7.3	29.0	8.0	8.0	5.8	5.2	4.9	5.1	5.5	5.5	6.2
9	15.4	7.3	20.3	7.8	7.7	5.7	5.2	4.9	5.1	5.3	5.5	6.2
10	13.6	7.1	16.4	7.6	7.5	5.7	5.2	4.9	5.0	5.3	5.4	6.2
11	12.3	7.0	14.3	7.5	8.6	5.7	5.2	4.9	5.0	5.2	5.4	6.1
12	11.6	7.0	13.1	9.6	8.3	5.7	5.1	4.9	5.0	5.2	5.4	6.0
13	10.9	6.9	12.2	9.7	7.9	5.6	5.1	4.9	5.0	5.2	5.4	6.0
14	10.3	6.8	11.3	9.0	7.5	5.6	5.1	4.9	5.0	5.1	5.3	9.9
15	11.1	6.7	11.0	8.7	7.4	5.6	5.1	4.9	5.0	5.1	5.3	8.6
16	10.8	6.9	10.4	8.3	7.2	5.8	5.1	4.9	5.0	5.1	5.4	9.9
17	10.7	6.8	10.0	8.2	7.2	5.7	5.1	4.9	5.0	5.1	8.5	12.7
18	10.3	6.8	9.6	8.0	7.1	5.7	5.1	4.9	5.0	5.2	8.5	9.9
19	10.0	7.9	9.6	7.9	7.0	5.7	5.1	4.9	5.0	9.5	7.0	9.9
20	9.6	9.8	9.2	8.2	6.9	5.6	5.1	4.9	5.0	8.7	6.6	12.3
21	9.3	10.9	9.1	8.8	6.8	5.6	5.0	4.9	5.0	7.8	13.0	22.5
22	9.0	12.1	9.0	9.0	6.7	6.0	5.0	4.9	5.0	6.1	8.1	15.2
23	8.7	10.1	8.8	8.2	6.6	5.8	5.0	4.9	5.0	6.0	7.2	13.2
24	8.4	9.4	8.7	7.8	6.6	5.8	5.0	4.9	4.9	5.8	6.8	11.0
25	8.3	8.8	8.5	7.5	6.5	5.7	5.0	4.9	4.9	5.6	7.5	10.2
26	7.6	9.0	8.5	7.4	6.5	5.7	5.0	4.9	4.9	5.5	8.9	9.1
27	7.9	8.7	8.2	7.3	6.4	5.6	5.0	4.9	4.9	5.5	8.2	8.6
28	7.8	8.3	8.1	7.3	6.3	5.5	4.9	4.9	4.9	5.5	8.5	8.1
29	7.7	.....	7.9	7.1	6.3	5.5	4.9	4.9	4.9	5.5	7.0	7.7
30	7.6	.....	7.8	7.0	6.1	5.4	4.9	4.9	4.9	5.5	6.9	7.6
31	7.7	.....	7.7	.....	6.1	.....	4.9	4.9	.....	5.5	.....	7.4

NORTH YUBA RIVER NEAR NORTH SAN JUAN, CALIFORNIA.

This station, established July 3, 1900, is at the Yuba Power Company's dam. The channel is irregular, composed of gravel, sand, and clay, and is subject to change during flood discharges. During 1900 the following measurements of discharge were made by H. D. H. Connick:

Discharge measurements of North Yuba River near North San Juan, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
July 3	2.05	606	July 31	1.60	364
July 6	1.95	567	August 9	1.55	328
July 17	1.70	438	August 10	1.57	322
July 18	1.65	419	August 29	1.48	282
July 27	1.65	366	August 30	1.48	285
July 29	1.60	371			

Daily gage height, in feet, of North Yuba River near North San Juan, California, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	.....	1.6	1.5	1.5	17	1.7	1.5	1.5	.....
2	.....	1.6	1.5	1.5	18	1.7	1.5	1.5	.....
3	2.1	1.5	1.4	2.2	19	1.7	1.5	1.5	.....
4	2.0	1.6	1.5	2.1	20	1.7	1.5	1.5	.....
5	2.0	1.5	1.5	2.7	21	1.6	1.5	1.5	.....
6	2.0	1.6	1.5	2.0	22	1.7	1.5	1.4	.....
7	2.0	1.5	1.5	1.8	23	1.7	1.5	1.4	.....
8	2.0	1.6	1.5	1.7	24	1.7	1.5	1.4	.....
9	1.9	1.5	1.5	1.7	25	1.6	1.5	1.5	.....
10	1.8	1.6	1.5	1.7	26	1.7	1.5	1.5	.....
11	1.8	1.5	1.5	1.6	27	1.6	1.5	1.5	.....
12	1.8	1.6	1.5	1.7	28	1.6	1.5	1.5	.....
13	1.8	1.5	1.5	1.6	29	1.6	1.5	1.5	.....
14	1.7	1.6	1.6	.....	30	1.6	1.5	1.5	.....
15	1.8	1.5	1.5	.....	31	1.6	1.5	.....	.....
16	1.7	1.5	1.5	.....					

MIDDLE YUBA RIVER NEAR NORTH SAN JUAN, CALIFORNIA.

This station, established July 1, 1900, is at Freeman's bridge. The channel is composed of sand and gravel, recently built up by débris from the mines above, and is subject to change during flood heights. During 1900 the following measurements of discharge were made by H. D. H. Connick:

Discharge measurements of Middle Yuba River near North San Juan, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
July 1	2.40	191	August 11	2.17	79
July 3	2.35	180	August 12	2.15	78
July 4	2.30	185	August 29	2.20	69
July 7	2.57	162	August 30	2.20	68
July 29	2.30	109	September 18	2.15	64

Daily gage height, in feet, of Middle Yuba River near North San Juan, California, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	2.4	2.2	2.1	2.0	17	2.3	2.1	2.2	2.1
2	2.4	2.2	2.1	2.0	18	2.3	2.2	2.1	2.0
3	2.4	2.1	2.0	2.5	19	2.4	2.2	2.2	2.1
4	2.3	2.2	2.0	2.4	20	2.4	2.1	2.1	2.0
5	2.4	2.1	2.1	3.0	21	2.4	2.2	2.0	.....
6	2.5	2.2	2.0	3.0	22	2.4	2.1	2.0	.....
7	2.6	2.1	2.1	2.4	23	2.4	2.2	2.0	.....
8	2.5	2.2	2.0	2.3	24	2.4	2.1	2.0	.....
9	2.5	2.1	2.1	2.2	25	2.3	2.1	2.0	.....
10	2.4	2.2	2.0	2.2	26	2.3	2.1	2.0	.....
11	2.4	2.2	2.0	2.1	27	2.4	2.1	2.0	.....
12	2.4	2.2	2.0	2.0	28	2.3	2.1	2.0	.....
13	2.3	2.1	2.3	2.0	29	2.3	2.1	2.0	.....
14	2.3	2.2	2.3	2.1	30	2.3	2.1	2.0	.....
15	2.3	2.1	2.2	2.0	31	2.2	2.1	.....	.....
16	2.4	2.2	2.2	2.0					

YUBA RIVER NEAR SMARTVILLE, CALIFORNIA.

This station, established June 28, 1900, is at Parks Bar Bridge. During recent years the channel of the river has been filled with sand and gravel, brought down from the hydraulic-mining camps in the mountains above, and thus is subject to change during flood stages. During 1900 the following measurements of discharge were made by H. D. H. Connick:

Discharge measurements of Yuba River near Smartville, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
June 28	3.15	1,212	July 24	2.50	673
June 29	2.95	1,086	August 7	2.23	537
July 11	2.65	821	August 8	2.30	571
July 12	2.65	811	August 14	2.25	534
July 18	2.60	774	August 28	2.20	474
July 22	2.42	622	September 14	2.60	736
July 23	2.50	686			

Daily gage height, in feet, of Yuba River near Smartville, California, for 1900.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1		2.9	2.3	2.1	2.0	17		2.5	2.1	2.2	
2		2.9	2.3	2.1	2.0	18		2.4	2.2	2.2	
3		3.0	2.2	2.1	3.1	19		2.4	2.2	2.2	
4		2.8	2.2	2.2	3.0	20		2.4	2.2	2.1	
5		2.7	2.2	2.4	2.4	21		2.3	2.3	2.1	
6		2.7	2.2	2.3	1.9	22		2.4	2.4	2.1	
7		2.7	2.3	2.2	1.5	23		2.5	2.2	2.0	
8		2.7	2.2	2.2	1.3	24		2.4	2.3	2.0	
9		2.6	2.3	2.2	1.3	25		2.5	2.1	2.0	
10		2.6	2.1	2.1	1.2	26		2.4	2.1	2.1	
11		2.7	2.2	2.2	1.2	27		2.3	2.2	2.0	
12		2.6	2.2	2.3	1.3	28	3.1	2.3	2.1	2.0	
13		2.6	2.2	2.4	1.2	29	3.0	2.4	2.1	2.0	
14		2.5	2.3	2.6		30	3.0	2.3	2.2	2.0	
15		2.5	2.1	2.4		31		2.3	2.1		
16		2.5	2.2	2.4							

CACHE CREEK, CALIFORNIA.

This stream is the outlet of Clear Lake, in Lake County, California. It flows southeasterly, its flood waters finding their way into Sacramento River between the mouths of Feather and American rivers. In 1889 Clear Lake was segregated as a reservoir site, as described in the Thirteenth Annual Report, Part III, pages 405 to 409. During 1900 a hydrographic examination of the entire basin of Cache Creek was made by A. E. Chandler, whose detailed report has been published as Water-Supply Paper No. 45. During the course of his investigations the following discharge measurements were made of the creek and its tributaries:

Discharge measurements of Cache Creek and its tributaries.

Date.	Stream.	Point of measurement.	Hydrographer.	Discharge.
1900.				*Sec.-ft.*
June 25	Cache Creek	At Rumsey	A. E. Chandler	189.0
June 27	do	At Bear Creek	do	156.0
June 29	do	At North Fork	do	161.4
July 17	do	At Clear Lake	do	106.9
July 20	do	At Rumsey	do	92.6
Do	do	At Tancred	do	89.4
July 21	do	At Capay	do	88.1
July 23	Adams ditch		do	6.8
Do	Cache Creek	At Madison	do	54.6
Do	do	At Moore's dam	do	69.0
July 24	Moore ditch		do	49.4
Do	Cache Creek	At Stevens's bridge	do	20.4
June 29	do	At Rumsey	J. M. Wilson	166.8
Do	do	At Tancred	do	167.5
Do	do	Five miles above Capay	do	173.6
June 28	do	At Capay	do	161.6
June 30	do	At Esparto	do	152.7
Do	do	At Madison bridge	do	140.9
Do	Moore ditch		do	60.5
July 3	Cache Creek	At Stevens's bridge	do	75.8
Do	do	At Nelson's bridge	do	53.0
Do	do	At Cache Creek Sink	do	51.3
Do	Tule canal	Opposite Woodland	do	29.7
Aug. 20	Cache Creek	At Clear Lake	do	39.6
Aug. 27	do	One-fourth mile above Rumsey	do	27.6
June 29	North Fork	At mouth	A. E. Chandler	5.1
June 30	do	Above Long Valley Creek	do	6.4
June 27	Bear Creek	At mouth	do	1.8
June 30	Long Valley Creek	do	do	2.9
Do	Wolf Creek	One mile above mouth	do	0.5
July 2	North Fork	Above Bartlett Creek	do	3.3
Do	Bartlett Creek	At mouth	do	1.4
Do	Stanton Creek	do	do	1.5
July 8	North Fork	At Little Indian Valley	do	2.8
July 12	Scotts Creek	Eight miles above Clear Lake	do	0.5
Do	Middle and Clover creeks.	At Upper Lake	do	1.5
July 16	Kelsey Creek	Two miles above Kelseyville	do	4.6

SALINAS RIVER NEAR SALINAS, CALIFORNIA.

Salinas River rises in San Luis Obispo County, flows in a northwesterly direction through Salinas Valley, and discharges into the Bay of Monterey. The crest of the Coast Range, locally known as the Santa Lucia Mountains, forms the boundary of the watershed on the south and west; the crest of the Gabilan Mountains forms the eastern boundary of the watershed. The total area drained is a little less than 5,000 square miles. The principal tributaries of the river drain the eastern slopes of the Santa Lucia Mountains, and are Nacimento and San Antonio creeks and the Arroyo Seco. The only important stream entering from the east is San Lorenzo Creek, which drains the western slopes of the Gabilan Mountains.

A reconnaissance survey for reservoir sites on Salinas River and its tributaries was made during the period from May 28 to August 31, 1900, under the direction of Prof. Charles D. Marx, of Stanford University. His report will appear in one of the series of Water-Supply Papers.

A gaging station was established on the river January 8, 1900, by D. A. Porter. On account of the shifting nature of the channel during floods, four gage rods were set between January 8 and April 2, 1900, and each was referred to a different datum. On June 8, 1900, a permanent station was established at the county bridge 3¾ miles south of Salinas.

The gage, which is vertical, is attached to one of the piers of the bridge. The bench mark is a nail in the washer in the top of a redwood post, 13 inches by 15 inches in size, on the north bank of the river, at an elevation of 20 feet above gage datum. The gage heights given in the following tables have been adjusted to the rod which was established June 8, 1900. During 1900 a number of measurements of discharge were made of Salinas River at the main gaging station and of Arroyo Seco, a tributary of Salinas River, by D. A. Porter and others. The results are given in the following tables:

Discharge measurements of Arroyo Seco, California.

Date.	Locality.	Discharge.
1900.		*Sec.-feet.*
June 20	The Pools	11.8
Do	do	12.4
June 21	Moore's	10.4
Do	Currier	7.3
Do	Joy's	6.1

Discharge measurements of Salinas River near Salinas, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 9	4.20	26	June 22	4.00	13
April 12	4.15	15	June 26	4.00	11
April 15	4.10	13	June 30	3.90	11
April 19	4.10	17	July 3	3.65	10
April 22	4.25	34	July 16	3.70	10
April 25	4.15	19	August 1	3.70	10
May 1	4.10	18	August 18	3.65	10
May 4	4.10	16	September 1	3.65	10
May 7	4.10	18	September 26	3.45	2
May 12	4.10	18	October 23	3.45	2
May 16	4.10	18	October 28	.....	1
May 19	4.10	16	November 14	3.70	9
May 24	4.10	17	November 16	3.80	21
May 29	4.10	17	November 17	4.20	32
June 2	4.05	13	November 19	6.70	2,056
June 5	4.05	15	November 20	5.90	829
June 8	4.00	15	November 21	5.60	743
June 12	4.05	16	November 22	15.60	33,600
June 15	4.05	15	November 23	9.70	12,851
June 18	4.00	14			

Daily gage height, in feet, of Salinas River near Salinas, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.10	4.40	4.20	4.10	4.05	3.80	3.70	3.60	3.40	3.40	6.00
2	.....	5.10	4.30	4.20	4.10	4.05	3.70	3.70	3.70	3.50	3.40	5.90
3	.....	5.00	4.30	4.30	4.10	4.05	3.65	3.60	3.60	3.40	3.40	5.80
4	.....	4.90	4.50	4.20	4.10	4.05	3.60	3.60	3.70	3.50	3.50	5.70
5	.....	4.90	4.60	4.20	4.10	4.05	3.60	3.60	3.60	3.40	3.60	5.60
6	.....	5.00	4.60	4.20	4.05	4.05	3.60	3.70	3.70	3.40	3.80	5.50
7	.....	5.00	4.50	4.20	4.05	4.05	3.60	3.70	3.60	3.40	3.40	5.40
8	7.10	4.90	4.50	4.20	4.05	4.05	3.70	3.70	3.70	3.40	3.50	5.30
9	6.90	4.90	5.10	4.20	4.05	4.05	3.70	3.70	3.60	3.50	3.40	5.30
10	6.70	4.90	5.00	4.20	4.05	4.05	3.80	3.70	3.70	3.40	3.40	5.20
11	6.50	4.90	5.00	4.10	4.05	4.05	3.80	3.70	3.60	3.40	3.40	5.10
12	6.30	4.90	5.00	4.10	4.05	4.05	3.60	3.70	3.70	3.40	3.50	5.10
13	6.10	4.80	4.90	4.10	4.05	4.05	3.60	3.70	3.70	3.40	3.70	5.00
14	6.00	4.80	4.90	4.10	4.05	4.05	3.70	3.70	3.60	3.45	3.70	5.00
15	5.90	4.70	4.90	4.10	4.05	4.05	3.70	3.70	3.70	3.35	3.70	5.00
16	5.70	4.70	4.80	4.10	4.05	4.00	3.70	3.70	3.60	3.45	3.80	5.00
17	5.70	4.70	4.70	4.10	4.05	4.00	3.70	3.60	3.70	3.35	4.10	5.00
18	5.60	4.60	4.60	4.10	4.05	4.00	3.70	3.70	3.60	3.45	5.50	5.00
19	5.50	4.70	4.60	4.10	4.05	4.00	3.70	3.70	3.70	3.45	6.70	5.00
20	5.50	4.70	4.50	4.10	4.05	4.00	3.70	3.60	3.60	3.45	5.90	4.90
21	5.40	4.60	4.40	4.20	4.05	4.00	3.70	3.70	3.60	3.40	5.70	4.90
22	5.40	4.50	4.40	4.20	4.05	4.00	3.70	3.60	3.50	3.40	15.60	4.90
23	5.30	4.40	4.40	4.20	4.05	4.00	3.70	3.70	3.50	3.40	9.70	4.80
24	5.30	4.40	4.40	4.10	4.05	4.00	3.70	3.60	3.50	3.40	8.60	4.80
25	5.30	4.40	4.30	4.10	4.05	4.00	3.70	3.70	3.50	3.40	7.90	4.80
26	5.20	4.40	4.30	4.10	4.05	4.00	3.70	3.60	3.40	3.40	7.40	4.70
27	5.20	4.40	4.30	4.10	4.05	4.00	3.70	3.70	3.50	3.40	7.00	4.70
28	5.20	4.40	4.30	4.10	4.05	4.00	3.70	3.60	3.40	3.40	6.60	4.70
29	5.20	.....	4.20	4.10	4.05	3.90	3.60	3.70	3.40	3.40	6.30	4.70
30	5.20	.....	4.20	4.10	4.05	3.90	3.70	3.60	3.40	3.40	6.10	4.70
31	5.10	.....	4.20	.....	4.05	.....	3.70	3.70	.....	3.40	.....	4.70

STANISLAUS RIVER NEAR OAKDALE, CALIFORNIA.

This station was first established May 3, 1896, and was relocated on July 30, 1898, as described in Water-Supply Paper No. 38, page 391. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 448.

The canal of what was formerly known as the Stanislaus and San Joaquin Water Company diverts water from Stanislaus River 3 miles above Knights Ferry, or approximately 15 miles above Oakdale. During the latter part of the year 1899 the management of the property

changed hands, and a new company was formed, under the name of Stanislaus Water Company. The station described in Water-Supply Paper No. 38 was discontinued in the latter part of 1899, on account of improvements to and enlargements of the canal, and on May 19, 1900, a new gaging station was established near the lower end of flume No. 3. It was rated, as in previous years, by turning various amounts of water into the flume and measuring the same with a meter. Owing to the lack of an observer on the canal, the record for 1900 is not complete. During the year the following measurements of discharge were made at the main station, under the direction of J. B. Lippincott:

April 5: Gage height, 6.82 feet; discharge, 1,703 second-feet.
May 19: Gage height, 9.33 feet: discharge, 4,515 second-feet.
June 21: Gage height, 6.65 feet; discharge, 1,438 second-feet.
August 11: Gage height, 4.38 feet; discharge, 66 second-feet.
September 6: Gage height, 4.25 feet; discharge, 35 second-feet.
December 28: Gage height, 5.66 feet; discharge, 611 second-feet.

Daily gage height, in feet, of Stanislaus River near Oakdale, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.0	5.8	5.6	7.5	6.4	8.1	6.0	4.5	4.2	4.4	5.0	6 2
2	7.6	5.9	5.6	7.5	6.7	7.8	5.6	4.5	4.2	4.5	5.0	6.4
3	11.2	5.7	5.8	7.2	7.0	7.6	5.6	4.5	4.2	4.7	5.0	6.3
4	10.9	5.7	6.8	7.0	7.4	7.8	5.5	4.5	4.2	5.0	5.1	6.1
5	8.7	5.6	7.2	6.9	8.2	7.5	5.5	4.5	4.2	5.3	5.0	5.9
6	8.2	5.6	6.8	6.8	8.2	7.9	5.4	4.5	4.2	5.2	5.2	5.9
7	8.0	5.5	6.4	6.7	8.5	7.8	5.4	4.5	4.2	5.2	5.0	5.9
8	8.0	5.6	6.6	6.5	8.7	7.7	5.4	4.5	4.2	5.2	5.0	5.9
9	7.8	5.5	6.8	6.7	8.6	8.0	5.3	4.5	4.2	5.0	5.1	5.9
10	7.5	5.5	6.8	6.6	8.6	7.6	5.2	4.4	4.2	4.9	5.1	5.7
11	7.2	5.4	6.8	6.6	8.7	7.4	5.2	4.4	4.2	4.8	5.1	5.6
12	6.8	5.5	7.0	6.7	8.4	7.4	5.2	4.3	4.2	4.8	5.1	5.6
13	6.5	5.5	7.3	6.5	8.0	7.5	5.2	4.3	4.2	4.7	5.2	5.6
14	6.5	5.4	7.7	6.7	7.4	7.3	5.0	4.3	4.2	4.7	5.2	5.6
15	6.5	5.5	7.3	6.5	7.7	7.0	5.0	4.3	4.2	4.7	5.6	5.7
16	6.4	5.5	7.4	6.4	8.1	6.8	5.0	4.3	4.2	4.8	6.0	5.6
17	*6.4	5.4	7.3	6.5	8.9	6.7	5.0	4.2	4.2	4.7	6.7	6.0
18	6.2	5.5	7.3	6.9	8.8	6.4	4.9	4.3	4.3	4.7	5.9	5.9
19	6.2	5.6	6.8	6.9	9.1	6.4	4.8	4.4	4.3	5.1	6.1	5.6
20	6.2	5.5	7.0	7.4	9.0	6.6	4.8	4.3	4.4	7.8	6.5	5.5
21	6.2	6.2	7.3	8.0	8.6	6.6	4.8	4.3	4.4	6.4	10.3	5.8
22	6.0	6.0	7.4	7.1	8.6	6.4	4.6	4.2	4.4	6.0	9.7	6.8
23	6.0	5.9	7.5	7.0	8.6	6.4	4.6	4.2	4.4	5.4	9.1	6.4
24	6.0	5.8	7.2	6.9	8.6	6.4	4.6	4.2	4.4	5.4	7.2	6.0
25	6.0	5.8	7.4	6.8	8.3	6.2	4.6	4.2	4.4	5.3	6.6	5.8
26	5.9	5.6	7.3	7.0	8.6	6.0	4.6	4.3	4.4	5.3	6.5	5.9
27	5.8	5.6	7.2	6.7	8.8	6.0	4.5	4.2	4.4	5.2	6.5	5.8
28	5.9	5.5	7.3	6.6	8.9	6.2	4.6	4.2	4.4	5.1	6.4	5.7
29	6.0	.....	6.9	6.6	8.1	6.0	4.5	4.2	4.4	5.1	6.2	5.6
30	5.9	.....	7.0	7.7	8.2	6.0	4.5	4.2	4.4	5.2	6.2	5.6
31	5.9	.....	7.2	.....	8.3	.....	4.4	4.3	.....	5.0	.....	5.5

TUOLUMNE RIVER AT LAGRANGE, CALIFORNIA.

This station, established August 29, 1895, is at the wagon bridge in Lagrange, and is below the high dam of the Turlock and Modesto irrigation districts, and also below the head of the canal of the Lagrange Hydraulic Mining Company. It is described in Water-Supply Paper No. 38, page 393. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 449. During 1900 the

following measurements of discharge were made under the direction of J. B. Lippincott:

Discharge measurements of Turlock canal.

Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*
April 6	2.00	129
June 22	.50	10
August 11	1.90	117
September 8	1.15	35

Discharge measurements of Tuolumne River at Lagrange, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 5	6.08	2,286	August 11	3.50	17.0
May 20	8.40	8,720	September 8	3.40	10.9
June 22	7.09	4,629	December 27	5.32	964.0

Daily gage height, in feet, of Tuolumne River at Lagrange, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.3	5.3	5.4	6.5	9.8	8.0	5.6	4.2	3.3	3.9	5.1	5.7
2	6.0	5.2	5.4	6.4	7.0	8.0	5.8	4.2	3.3	3.8	5.1	5.7
3	9.8	5.2	5.3	6.5	7.2	7.9	5.7	4.0	3.3	3.7	5.0	5.7
4	8.1	5.2	6.0	6.4	7.2	7.7	5.4	4.0	3.4	4.9	4.9	5.7
5	7.0	5.2	5.9	6.1	7.4	7.8	5.3	3.9	3.3	6.0	4.8	5.7
6	6.7	5.1	5.8	5.8	6.9	8.0	5.2	3.9	3.2	5.5	4.6	5.6
7	6.4	5.1	5.8	6.0	7.1	8.2	5.1	3.7	3.3	5.2	5.5	5.6
8	6.3	5.1	5.9	5.9	7.4	8.4	5.3	3.6	3.2	5.1	5.6	5.7
9	6.2	5.0	5.9	5.9	7.5	8.0	5.0	3.6	3.4	5.2	5.4	5.7
10	6.0	5.0	6.0	5.9	7.8	7.8	5.0	3.5	3.5	5.3	5.3	5.6
11	5.9	5.0	6.1	5.8	7.7	7.8	5.0	3.5	3.5	5.2	5.3	5.6
12	5.8	5.1	6.2	5.8	7.4	7.4	4.5	3.5	3.4	5.2	5.1	5.5
13	5.8	5.0	6.3	5.7	7.4	7.4	4.8	3.4	3.4	5.2	5.1	5.4
14	5.8	5.1	6.3	5.7	7.4	7.4	4.6	3.5	3.4	5.2	5.0	5.4
15	5.7	5.1	6.4	5.6	7.6	7.3	5.2	4.0	3.4	5.2	4.9	5.4
16	5.7	5.2	6.4	5.8	7.7	6.9	5.0	4.0	3.4	5.2	4.8	5.4
17	5.7	5.1	6.5	5.8	8.5	6.8	5.0	3.9	3.3	5.2	6.1	5.4
18	5.7	5.1	6.4	6.1	8.5	7.0	5.1	3.9	3.3	5.2	6.4	5.6
19	5.7	5.1	6.3	6.4	8.4	7.2	4.8	3.9	3.3	5.2	6.1	5.4
20	5.7	5.3	6.5	7.0	8.6	7.2	4.8	3.8	3.4	7.6	10.2	5.4
21	5.6	5.5	6.4	6.9	8.5	7.3	4.7	3.8	3.4	6.5	9.2	5.4
22	5.6	5.5	6.4	6.6	8.5	7.1	4.6	3.6	3.5	6.0	8.3	5.9
23	5.5	5.4	6.4	6.5	8.3	6.8	4.6	3.6	3.4	5.9	7.1	5.7
24	5 5	5.3	6.3	6.3	8.4	6.8	4.4	3.5	3.3	5.6	6.5	5.6
25	5.5	5.4	6.2	6.2	8.2	6.6	4.5	3.4	3.3	5.5	6.3	5.5
26	5.4	5.3	6.1	6.2	8.4	6.5	4.3	3.4	3.3	5.4	6.1	5.4
27	5.4	5.4	6.1	6.1	8.4	6.4	4.2	3.4	3.5	5.2	6.1	5.3
28	5.4	5.4	6.1	6.0	8.3	6.4	4.2	3.4	4.1	5.3	6.0	5.2
29	5.3	.....	6.0	6.2	8.2	6.2	4.4	3.3	3.9	5.2	5.9	5.2
30	5.3	.....	6.1	6 4	7.8	6.1	4.3	3.3	3.9	5.2	5.8	5.2
31	5.3	.....	6.4	.....	8.2	.....	4.4	3.3	.....	5.0	.....	5.1

Estimated daily discharge, in second-feet, of Turlock canal, California, for 1900.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	64	64	000	133	133	133	133	28
2	64	64	000	133	133	133	133	36
3	64	64	000	133	133	133	133	36
4	64	64	000	133	133	133	133	36
5	64	64	133	133	133	133	133	36
6	64	64	133	133	133	133	133	36
7	64	64	133	133	133	133	000	36
8	64	64	000	133	133	133	000	36
9	64	64	000	133	133	133	000	36
10	64	64	133	133	9	133	000	36
11	64	64	133	133	9	133	000	36
12	64	133	133	133	9	133	000	36
13	64	133	133	133	9	133	114	36
14	64	85	133	133	9	133	114	36
15	64	85	64	133	9	133	85	36
16	64	85	64	133	9	133	85	36
17	64	85	64	133	9	133	00	36
18	64	64	64	133	9	133	00	36
19	85	64	64	133	9	133	00	36
20	133	85	64	133	9	133	00	28
21	133	85	64	133	9	133	00	28
22	28	85	133	133	9	133	64	28
23	28	85	133	133	9	133	64	28
24	28	85	133	133	9	133	74	00
25	28	85	133	133	133	133	64	00
26	28	85	133	133	133	133	55	00
27	40	85	133	133	133	133	55	00
28	64	85	133	133	133	000	64	00
29	.....	133	133	133	133	000	64	00
30	.....	133	133	133	133	006	28	00
31	.....	133	.....	133	.....	133	28	.....
Mean	62	84	90	133	71	120	57	26

NOTE.—There was no flow during the months of January, October, November, and December.

Miscellaneous discharge measurements of Tuolumne River, California.

Date.	Locality.	Hydrographer.	Discharge.
1899.			*Sec.-feet.*
July 31	Below Rancheria Creek, Hetch Hetchy Valley.	H. Ramel	238
August 5	do	do	230
August 12	do	do	131
August 19	do	do	101
August 23	do	do	69

SAN JOAQUIN RIVER AT HERNDON, CALIFORNIA.

This station, established by the Southern Pacific Railway Company in 1879, is at the iron highway bridge crossing the river at Herndon. The bed of the stream is of sand and gravel, and the section has changed materially several times during 1900. A reconnaissance has been made of the river above Pollasky, with the view to locating a new station where the section will be permanent, and a relocation will probably be made in 1901. The station at Herndon is described in Water-Supply Paper No. 38, page 395. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV,

page 466. During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

Discharge measurements of San Joaquin River at Herndon, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 3	4.66	2,641	September 1	2.50	246
May 15	5.91	4,448	September 28	2.33	197
June 18	5.67	3,710	December 30	3.33	614
August 9	2.83	466			

Daily gage height, in feet, of San Joaquin River at Herndon, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.8	3.3	3.2	4.8	4.5	7.2	5.3	3.0	2.6	2.4	2.7	3.8
2	4.7	3.2	3.3	4.6	4.5	7.3	5.0	3.0	2.5	2.4	2.7	3.8
3	9.3	3.3	3.3	4.4	4.5	7.1	4.9	3.0	2.5	2.3	2.6	3.8
4	10.2	3.3	3.6	4.6	4.5	7.0	4.4	3.0	2.5	2.3	2.6	3.7
5	5.8	3.1	4.9	4.4	4.8	6.9	4.3	3.0	2.4	2.7	2.6	3.7
6	4.9	3.1	3.6	4.4	5.1	6.8	4.2	3.0	2.4	3.3	2.5	3.7
7	4.5	3.0	3.1	4.3	5.1	7.4	4.2	2.9	2.5	3.0	2.5	3.7
8	4.2	3.0	3.1	4.1	5.3	7.5	4.2	2.8	2.5	2.8	2.5	3.7
9	4.1	3.0	3.1	4.4	5.4	7.6	4.3	2.8	2.5	2.8	2.5	3.8
10	3.9	3.0	3.1	4.2	6.1	7.4	4.3	2.8	2.5	2.8	2.5	3.8
11	3.1	3.0	4.0	4.4	6.5	6.9	4.1	2.8	2.4	2.8	2.7	3.8
12	3.1	3.0	4.0	4.2	6.3	6.6	4.0	2.7	2.4	2.8	2.7	3.7
13	3.7	3.0	4.1	4.2	5.8	6.3	4.0	2.7	2.4	2.8	2.7	3.6
14	3.7	3.0	4.4	4.2	5.3	6.3	4.0	2.7	2.4	2.8	2.6	3.6
15	3.7	3.0	4.7	4.2	5.2	6.1	3.9	2.7	2.4	2.8	2.6	3.6
16	3.7	3.0	4.7	4.2	6.2	5.8	3.8	2.7	2.4	2.7	2.6	3.5
17	3.7	3.0	4.6	4.1	7.2	5.5	3.8	2.7	2.4	2.8	2.7	3.5
18	3.7	2.9	4.6	4.0	7.2	5.7	3.7	2.7	2.4	2.7	4.1	3.5
19	3.7	3.2	4.6	4.1	7.9	5.8	3.6	2.6	2.4	2.8	3.7	3.5
20	3.7	3.3	4.6	4.6	7.6	5.7	3.6	2.6	2.3	2.8	3.7	3.5
21	3.7	3.3	4.6	4.9	7.4	6.5	3.5	2.6	2.3	3.1	4.9	3.5
22	3.5	3.3	4.6	4.8	7.7	6.4	3.5	2.6	2.3	3.3	12.0	3.5
23	3.5	3.1	4.6	4.7	8.0	6.2	3.5	2.6	2.3	3.1	6.8	3.5
24	3.4	3.0	4.4	4.5	7.5	5.9	3.5	2.6	2.3	3.0	5.6	3.5
25	3.2	3.0	4.3	4.5	7.1	5.9	3.2	2.6	2.3	3.0	4.7	3.4
26	3.3	3.0	4.3	4.5	7.1	5.7	3.2	2.6	2.3	2.8	4.5	3.3
27	3.2	3.0	4.3	4.5	7.4	5.5	3.1	2.6	2.3	2.8	4.2	3.4
28	3.3	3.0	4.3	4.3	7.3	5.6	3.1	2.6	2.3	2.7	4.0	3.4
29	3.3	.....	4.2	4.2	7.1	5.6	3.0	2.6	2.3	2.7	4.0	3.3
30	3.3	.....	4.3	4.2	7.2	5.4	3.0	2.6	2.4	2.6	3.8	3.3
31	3.2	.....	4.4	.....	7.3	.....	3.0	2.6	.....	2.7	.....	3.3

KING RIVER NEAR RED MOUNTAIN, CALIFORNIA.

The waters of King River, coming from a high catchment basin on the western slope of the Sierra Nevada, are probably of greater value for irrigation purposes than those of any other stream in central California. During the summer of 1900 the mountainous basin of the river was explored for reservoir sites and for power possibilities, and although numerous reservoir sites were surveyed, not one of them was considered commercially feasible. A good reservoir site was discovered, however, in Clarks Valley, in the foothills outside of King River Canyon. A reservoir at that place could be filled with water from King River that would run to waste during the fall and winter months, and by utilizing electric power developed from the river for pumping purposes, the amount of irrigated land in the vicinity of Fresno could be doubled.

The gaging station, established September 3, 1895, is southwest of Red Mountain and is 15 miles east of Sanger, at the mouth of the canyon of the river and above all diversions. It is described in Water-Supply Paper No. 39, page 403. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 468. During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

Discharge measurements of King River near Red Mountain, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 4	6.54	2,035	September 4	4.28	405
May 16	9.20	6,436	September 27	3.82	220
June 19	8.59	5,072	December 29	4.65	576
August 10	4.30	427			

Daily gage height, in feet, of King River near Red Mountain, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.4	5.0	5.0	7.3	6.6	9.6	7.0	4.6	3.9	3.8	3.9	5.3
2	6.3	5.0	5.0	6.9	6.5	9.7	6.8	4.7	3.9	3.7	4.0	5.3
3	11.3	5.0	5.0	6.8	6.5	9.4	6.5	4.7	3.8	3.8	3.9	5.1
4	8.4	5.0	6.9	6.5	6.7	9.4	6.3	4.7	4.3	4.0	3.9	5.1
5	7.0	5.0	6.1	6.6	7.1	9.3	6.2	4.6	4.5	4.1	3.9	5.1
6	6.6	4.9	5.7	6.5	7.3	9.3	6.1	4.5	4.3	4.2	3.9	5.1
7	6.3	4.9	5.5	6.9	7.5	9.3	6.4	4.8	4.2	4.0	3.8	5.2
8	6.0	4.9	5.3	6.4	7.8	9.2	6.4	4.4	4.2	4.0	3.8	5.2
9	5.9	4.8	5.4	6.1	8.2	8.9	6.3	4.4	4.1	4.0	3.9	5.2
10	5.7	4.8	5.7	6.5	8.6	8.7	6.3	4.3	4.1	3.9	3.9	5.0
11	5.6	4.8	6.0	6.3	8.9	8.5	6.2	4.3	4.0	3.9	3.9	5.0
12	5.5	4.8	6.1	6.2	7.9	8.4	6.1	4.2	4.0	3.9	3.8	4.9
13	5.5	4.8	(a)	6.2	7.7	8.5	6.0	4.1	3.9	3.9	3.8	4.9
14	5.5	4.8	.....	6.4	7.9	8.3	5.8	4.1	3.9	3.9	3.8	4.8
15	5.5	4.8	.....	6.0	8.4	8.1	5.7	4.1	3.9	3.9	3.8	5.0
16	5.5	4.8	.....	6.2	9.1	8.0	5.6	4.1	3.9	3.9	4.0	4.8
17	5.4	4.8	.....	6.3	9.8	8.0	5.4	4.9	3.9	3.9	7.3	4.8
18	5.5	4.9	6.7	7.1	10.0	8.3	5.3	4.1	3.9	3.9	4.8	5.0
19	5.4	5.0	6.6	7.0	10.0	8.6	5.3	4.0	3.8	3.9	4.7	4.9
20	5.4	5.1	6.5	7.2	9.9	8.7	5.3	4.0	3.8	3.9	4.7	4.8
21	5.4	5.0	6.5	7.3	9.9	8.6	5.3	4.0	3.8	4.3	12.4	4.8
22	5.3	5.0	6.6	7.0	10.0	8.5	5.4	4.1	3.7	4.2	8.0	4.8
23	5.3	5.0	6.5	6.9	10.2	8.2	5.2	4.0	3.7	4.1	6.5	4.9
24	5.3	5.0	6.5	6.9	9.5	8.1	5.7	4.0	3.8	4.1	6.2	4.9
25	5.3	5.0	6.5	6.8	9.2	8.1	5.0	3.9	3.7	4.0	6.0	.....
26	5.2	5.0	6.8	6.7	10.0	8.2	4.9	3.9	3.8	4.0	5.8	4.7
27	5.1	5.0	6.6	6.8	9.8	8.0	4.8	3.9	3.8	4.0	5.5	4.7
28	5.1	5.0	6.6	6.5	9.8	7.8	4.8	3.9	3.8	4.0	5.5	4.7
29	5.1	.....	6.7	6.5	9.5	7.7	4.7	3.9	3.8	3.9	5.3	4.7
30	5.1	.....	6.8	6.6	10.0	7.4	4.7	3.8	3.8	3.9	5.4	4.6
31	5.1	.....	7.1	.....	10.0	.....	4.6	3.8	.....	3.9	.....	4.6

a March 13 to 17 no readings.

KING RIVER NEAR KINGSBURG, CALIFORNIA.

The Southern Pacific Railroad Company has maintained gage readings at the railroad bridge 1 mile south of Kingsburg since 1879, and it is through their courtesy that the following record of gage heights for 1900 has been furnished to the Survey. Gage heights for 1899 will be found in Water-Supply Paper No. 39, page 405. No measurements of discharge were made here during 1900.

Daily gage height, in feet, of King River near Kingsburg, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.58	5.58	4.75	4.50	4.33	8.33	5.50	4.75	3.42	4.00	3.33	5.42
2	6.42	5.50	4.83	4.92	4.42	8.33	5.33	4.67	3.49	3.83	3.42	5.33
3	8.83	5.42	4.92	4.50	4.25	8.25	4.75	4.67	3.42	3.75	3.58	5.25
4	9.50	5.42	5.17	4.00	4.25	8.00	4.25	4.67	3.42	3.75	3.58	5.25
5	7.75	5.33	6.75	3.58	4.67	7.67	3.83	4.67	3.42	3.83	3.58	5.33
6	7.16	5.25	5.25	3.33	6.00	7.67	4.50	4.58	3.67	4.42	3.50	5.33
7	6.92	5.08	4.92	3.58	5.50	8.00	4.50	4.58	3.75	4.50	3.42	5.25
8	6.75	4.83	4.50	5.75	5.83	8.08	4.67	4.58	3.58	4.25	3.42	5.42
9	6.50	4.50	4.25	5.00	6.50	7.83	5.00	4.58	3.58	3.75	3.50	5.42
10	6.42	4.50	4.17	4.92	7.17	7.67	5.50	4.58	3.58	3.25	3.50	5.33
11	6.33	4.33	4.83	4.58	7.50	7.08	5.33	4.58	3.50	3.17	3.50	5.25
12	6.25	4.25	5.17	4.58	7.75	7.33	5.00	4.42	3.42	3.17	3.58	5.17
13	6.17	4.25	5.00	4.67	7.08	6.83	4.83	4.33	3.33	3.17	3.58	5.00
14	6.17	4.50	5.25	4.75	6.75	6.83	5.00	4.25	3.33	3.00	3.50	4.83
15	6.17	4.92	5.50	4.67	6.92	6.58	4.75	4.17	3.25	2.92	3.50	4.75
16	6.17	4.50	5.58	4.58	8.00	6.50	4.50	4.08	3.25	3.08	3.75	5.00
17	6.17	4.25	4.92	4.67	8.75	6.42	4.33	4.00	3.75	3.17	4.58	4.83
18	6.17	4.25	5.00	4.25	9.00	6.33	4.17	3.83	3.92	3.17	7.00	4.83
19	6.12	4.25	5.00	4.25	9.00	6.50	4.25	3.75	3.92	3.17	5.83	4.92
20	6.08	4.50	5.08	4.67	9.25	6.75	4.25	3.67	3.83	3.08	5.50	4.92
21	6.08	4.58	4.50	5.50	9.08	6.83	4.17	3.58	3.33	3.08	8.42	4.83
22	6.08	4.83	4.42	5.50	9.50	6.75	4.33	3.50	3.17	3.83	12.58	4.83
23	6.08	4.83	4.25	5.50	9.17	6.58	4.42	3.50	3.17	3.67	7.17	4.83
24	6.00	4.83	4.17	5.25	9.08	6.42	4.50	3.42	3.08	3.50	6.50	4.58
25	6.00	4.75	4.17	4.67	8.25	6.25	4.50	3.33	3.00	3.50	6.17	4.58
26	5.92	4.75	4.25	4.67	8.50	6.08	4.50	3.58	3.17	3.42	6.00	5.00
27	5.83	4.67	5.00	4.33	8.75	6.08	4.67	3.58	3.33	3.33	5.92	4.83
28	5.75	4.83	4.50	4.00	9.00	6.17	4.67	3.50	3.92	3.33	5.75	4.58
29	5.75	.....	4.17	3.83	8.25	6.08	4.67	3.50	4.17	3.33	5.50	4.58
30	5.67	.....	4.42	4.00	8.50	5.92	4.75	3.42	4.00	3.33	5.42	4.33
31	5.67	.....	4.83	.....	8.50	.....	4.75	3.42	.....	3.42	.....	4.25

KERN RIVER BASIN, CALIFORNIA.

During the summer of 1900 a reconnaissance of the drainage basin of Kern River was made by Mr. Frank H. Olmsted, whose report has been published in Water-Supply Paper No. 46. The following table gives the discharge measurements of the streams which were made during the progress of the investigation, arranged in geographic order, from the head downstream:

Miscellaneous discharge measurements in Kern River Basin.

Date.	Stream.	Locality.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-feet.*
June 25	Whitney Creek	Tunnel on divide	.....	4.72
June 27	....do	Lava bridge	.....	39.11
Do	Creek south of Bald Mountain.	Near mouth	.....	17.64
Do	North Fork of Kern River.	800 feet above Kern Lake	.....	939.60
June 25	Onemile Creek	1 mile below Kern Lake	.....	4.87
Do	Harris Creek	At mouth	.....	8.45
Do	North Fork of Kern River.	3,000 feet above junction with Little Kern River.	0.385	1,154.90
June 24	Little Kern River	At junction with Kern River	.....	81.00
Do	North Needles Creek	At Needles Peak	.....	4.26
June 29	Tibbetts Creek	8,300 feet elevation	.....	1.80
June 25	....do	1 mile above mouth	.....	2.87
June 23	South Needles Creek	Needles Peak	.....	5.82
Do	Clark Creek	Dry Meadows	.....	5.19
June 29	Brush Creek	Above North Fork; elevation 5,600	.....	8.22
Do	North Fork of Brush Creek.	Elevation 5,800	.....	1.04
June 23	Jackson Creek	Dry Meadows	.....	5.74
Do	Wade Creek	....do	.....	5.07
June 22	Tobias Creek	At mouth	.....	2.92
June 30	Salmon Creek	Horse Meadows	.....	4.05
June 22	....do	At mouth	.....	3.45
Do	Ant Creek	....do	.....	.18
June 21	Bull Run Creek	Near mouth	.....	2.30

Miscellaneous discharge measurements in Kern River Basin—Continued.

Date.	Stream.	Locality.	Gage height.	Discharge.
			Feet.	*Sec.-feet.*
June 22	Corral Creek	Near mouth		0.32
July 3	Hooper's mill ditch	Gaging station		7.31
June 20	North Fork of Kern River.	4,000 feet above junction with South Fork, at Hooper's mill bridge (new gaging station).	4.600	1,333.17
June 30	do	do	4.135	825.25
June 28	South Fork of Kern River.	Menache Meadows		3.67
July 2	Powers's ditch	Near head		2.38
Do	South Fork of Kern River.	T. 25 S., R. 35 E		11.05
June 20	do	700 feet above junction with North Fork.		14.18
July 3	Neil's ditch	Isabella		1.96
June 19	Basin Creek	Rankins's ranch, Walkers Basin		1.32

The California Power Company maintained observations on the North Fork of Kern River just below the mouth of Tobias Creek from July 21 to October 16, inclusive, 1900, from which daily discharge measurements have been estimated. The following record has been furnished to the Survey through the courtesy of F. C. Finkle, chief engineer of the California Power Company:

Estimated daily discharge, in second-feet, of North Fork of Kern River below the mouth of Tobias Creek, California, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1		334	213	204	18		206	215	
2		338	310	205	19		202	211	
3		306	308	208	20		198	211	
4		253	274	204	21	353	195	211	
5		244	256	203	22	345	194	207	
6		235	253	203	23	340	193	207	
7		231	246	202	24	336	196	207	
8		230	244	201	25	328	195	209	
9		229	244	201	26	319	198	208	
10		229	235	202	27	308	194	208	
11		226	232	202	28	298	186	206	
12		227	233	202	29	291	187	205	
13		226	230	202	30	285	181	207	
14		224	223	201	31	282	178		
15		222	220	201					
16		222	220	200	Mean	317	222	229	203
17		213	214						

KERN RIVER NEAR BAKERSFIELD, CALIFORNIA.

This station, established in 1893 by Mr. Walter Jones, chief engineer of the Kern County Land Company, is located at what is known as First Point of Measurement, 5 miles above Bakersfield, and at the mouth of the canyon of the river. Meter measurements are taken once a week, and an automatic gage records daily fluctuations of the river heights. Mr. A. K. Warren, the engineer in charge of this work for the Kern County Land Company, attends to the discharge measurements with much accuracy and precision, and furnishes the Survey with the final results. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 469.

Estimated daily discharge, in second-feet, of Kern River near Bakersfield, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	468	301	325	455	481	1,758	796	209	108	145	167	430
2	356	291	327	477	491	1,774	733	191	116	142	170	420
3	359	287	331	506	475	1,772	665	188	132	142	173	410
4	712	282	343	499	456	1,759	607	194	147	148	172	405
5	753	276	374	486	495	1,629	548	195	190	147	184	405
6	570	268	392	497	633	1,476	500	189	259	155	181	410
7	486	259	357	495	620	1,481	479	179	257	164	177	423
8	425	255	369	497	563	1,568	485	169	241	165	174	415
9	390	250	359	493	580	1,563	487	178	221	157	174	415
10	359	262	358	455	668	1,483	492	172	213	153	176	412
11	339	267	357	418	1,060	1,379	458	159	188	153	172	409
12	325	259	377	399	974	1,346	425	161	175	151	169	397
13	308	262	405	415	913	1,304	408	158	175	152	170	382
14	301	257	432	442	897	1,267	394	149	171	156	165	371
15	296	266	484	410	858	1,188	395	141	171	158	168	375
16	298	265	482	407	865	1,081	374	130	166	156	191	365
17	293	261	476	397	1,004	1,010	350	123	157	161	228	357
18	284	260	456	395	1,231	948	315	117	156	160	325	353
19	280	292	460	404	1,391	999	293	117	152	154	352	382
20	289	308	463	428	1,514	1,137	283	120	146	153	310	376
21	311	299	442	504	1,558	1,252	274	120	139	151	499	358
22	324	307	419	567	1,560	1,283	269	120	139	160	1,005	346
23	324	308	421	564	1,675	1,210	274	122	142	165	994	350
24	312	296	453	560	1,683	1,123	283	114	144	171	698	330
25	310	291	418	552	1,485	1,073	251	111	140	175	639	316
26	307	298	427	537	1,539	983	230	109	141	173	578	327
27	307	305	455	511	1,726	931	225	111	153	176	572	344
28	297	313	479	478	1,852	936	217	108	156	175	553	341
29	283	------	472	454	1,733	924	213	103	151	180	488	325
30	274	------	438	465	1,716	865	220	106	147	175	454	307
31	290	------	445	------	1,736	--------	222	103	------	170	------	299
Mean	362	280	413	472	1,111	1,283	392	144	166	159	349	373

MOHAVE RIVER AT VICTORVILLE, CALIFORNIA.[1]

This station, established February 27, 1899, is at the wagon bridge at the gorge at Victorville known as The Narrows. It is described in Water-Supply Paper No. 39, page 408. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 473. During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

Discharge measurements of Mohave River at Victorville, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-feet.*	1900.	*Feet.*	*Sec.-feet.*
April 14	0.90	32	June 3	0.90	23
April 28	.90	33	June 20	.85	27
May 11	.90	35	July 6	.85	31
May 23	.90	29	July 25	.85	28
May 29	.90	22			

[1] The name of this town has recently been changed from Victor to Victorville.

Daily gage height, in feet, of Mohave River at Victorville, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.10	1.10	1.00	0.90	0.90	0.80	0.85	0.85	0.85	0.90	0.90
2	1.00	1.10	1.10	1.00	.90	.90	.80	.85	.85	.85	.90	.90
3	1.00	1.10	1.20	1.00	.90	.90	.80	.85	.85	.85	.90	.90
4	1.00	1.10	1.20	1.00	.90	.90	.80	.85	.85	.85	.90	.90
5	1.00	1.10	1.20	1.00	.90	.90	.80	.85	.85	.85	.90	.90
6	1.00	1.10	1.20	.90	.90	.90	.80	.85	.85	.85	.90	.90
7	1.00	1.10	1.10	.90	.90	.90	.80	.85	.85	.85	.90	.90
8	1.00	1.10	1.10	.90	.90	.90	.80	.85	.85	.85	.90	.90
9	1.00	1.10	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
10	1.00	1.00	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
11	1.00	1.00	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
12	1.00	1.00	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
13	1.00	1.00	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
14	1.00	1.00	1.10	.90	.90	.90	.80	.85	.85	.90	.90	.90
15	1.00	1.00	1.00	.90	.90	.90	.80	.85	.85	.90	.90	.90
16	1.00	1.00	1.00	.90	.90	.90	.80	.85	.85	.90	.90	.90
17	1.00	1.00	1.00	.90	.90	.90	.80	.85	.85	.90	.90	.90
18	1.00	1.00	1.00	.90	.90	.90	.80	.85	.85	.90	.90	.90
19	1.00	1.00	1.00	.90	.90	.85	.80	.85	.85	.90	.90	.90
20	1.00	1.00	1.00	.90	.90	.85	.80	.85	.85	.90	.90	.90
21	1.00	1.00	1.00	.90	.90	.85	.80	.85	.85	.90	3.00	.90
22	1.00	1.00	1.00	.90	.90	.80	.85	.85	.85	.90	.90	.90
23	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
24	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
25	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
26	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
27	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
28	1.00	1.00	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
29	1.00	.....	1.10	.90	.90	.80	.85	.85	.85	.90	.90	.90
30	1.00	.....	1.00	.90	.90	.80	.85	.85	.85	.90	.90	.90
31	1.00	.....	1.00	.....	.90	.....	.85	.85	.....	.90	.....	.90

LOS ANGELES RIVER AT THE NARROWS, CALIFORNIA.

Los Angeles River heads immediately south of Santa Clara River, its various tributaries receiving their supply from the mountains surrounding the San Fernando Plains. It passes out of the lower end of the plain through a narrow valley known as The Narrows, at the lower end of which is the city of Los Angeles. The streams entering San Fernando Valley have brought down immense quantities of sand and gravel from the mountainous area, and thus have formed the San Fernando Plains. This coarse deposit acts as a natural regulator, absorbing the flood waters, which gradually appear lower down. The rainfall of southern California has been deficient for the last few years, but the discharge of Los Angeles River at The Narrows has been exceptionally constant, the decrease in 1900 being not more than 20 per cent of the average. On account of the numerous lawsuits which have arisen regarding water rights on this river, a thorough study of its discharge has been instituted by the city of Los Angeles, the work being under the direction of J. B. Lippincott, as consulting engineer for the city. The majority of the measurements have been made by C. A. Miller, although a number of them were made by F. H. Olmsted, city engineer. Several weirs have been placed in the river where the measurements are made. The points of measurements are as follows, in order downstream:

Weir A, at the intersection of Pacoima avenue with Los Angeles River, in the Lankershim Rancho subdivision.

Weir B, at the intersection of Vineland avenue with Los Angeles River.

Weir C, at the intersection of Fernando avenue with Los Angeles River.

Weir E, at the southwest corner of block 73, Providencia Rancho.

Weir G, at the intersection of the east line of block 71, Providencia Rancho, with Los Angeles River.

Weir L, 770 feet above weir H.

Weir H, approximately 300 feet east of the intersection of Buena Vista street with Los Angeles River.

Weir I, 2,543 feet below weir H.

Weir J, 600 feet east of the west line of block 69, Providencia Rancho.

Weir K, in block 79, Providencia Rancho, 300 feet west of center.

Measuring bridge P, near the southwest corner of block 81, Providencia Rancho, in the headworks site of the city of Los Angeles, commonly known as the Pomeroy & Hooker tract, where river turns to the east at angle of 90 degrees.

Measuring bridge Q, about 400 feet above the junction of the Verdugo Wash with Los Angeles River.

Measuring bridge No. 2, about 600 feet above the head of the power ditch of the Los Angeles City Water Company, in the so-called Crystal Springs tract.

Weir No. 7, 1 mile below the head, in the main supply ditch, sometimes called the Woolen Mill ditch, in the headworks site.

Measuring point No. 7B, at a 3-foot cement pipe in the same ditch, west of bridge No. 2 and at the Los Felix ranch house.

Weir No. 17, opposite bridge No. 2, on what is called the Glassell tributary.

(To get the total flow of river at bridge No. 2, there should be combined the flow at bridges No. 2, No. 17, and No. 7B. In case measurements were not taken on the main supply ditch at No. 7B, the measurement observed at weir No. 7, above No. 7B on the main supply ditch, was used, and the loss between No. 7 and No. 7B, 2.49 second-feet, was deducted. This is shown in detail in the table for bridge No. 2. For bridge Q a similar process is followed, omitting No. 17. For bridge P the observed flow at the bridge is combined with either the flow at No. 7 or at No. 7B.)

Weir No. 9, at the mouth of Tujunga Creek, near the western end of the headworks site, and near the intersection of Buena Vista street with Los Angeles River.

Weir No. 10, approximately 200 feet west of weir No. 9, at the outlet of a small cut which was run into the gravel bed for the development of water.

Weir M, block 67, Providencia Rancho, on a small stream entering the river in the headworks tract.

Discharge measurements of Los Angeles River at weir A.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	0.565	0.612	May 17	0.461	0.461
August 19	.660		June 12	.461	.431
September 20	.500	.500	June 29	.402	
September 26	.500		August 1	.310	
October 24	.687	.687	August 8	.368	.370
November 24	.725	.723	August 15	.372	
November 28	.721		August 31	.430	
December 7	.678	.723	September 8	.378	
December 28	.768		September 11	.400	.368
			September 27	.328	
			November 10	.380	.380
Mean		.649	Mean		.402

Discharge measurements of Los Angeles River at weir B.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	0.500	0.500	May 17	0.482	0.482
September 20	.500	.500	June 12	.430	.355
September 26	.500		June 29	.280	
October 24	.755	.755	July 27	.160	.160
November 24	.937	.939	August 1	.180	.198
November 28	.941		August 15	.197	
December 7	.864	.923	August 31	.219	
December 28	.982		September 8	.209	.203
			September 11	.223	
			September 27	.176	
			November 10	.260	.260
Mean		.723	Mean		.276

Discharge measurements of Los Angeles River at weir C.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	2.88	2.88	May 17	2.98	2.98
August 28	2.88		June 12	2.91	2.91
September 20	2.69	2.48	July 27	2.45	2.45
September 26	2.26		August 1	2.50	2.50
October 9	2.88	2.93	August 8	2.48	
October 24	2.98		August 15	2.48	
November 24	3.45	3.43	August 31	2.55	
November 28	3.42		September 8	1.58	1.86
December 28	3.44	3.44	September 11	2.38	
			September 27	1.63	
			November 10	2.42	2.42
Mean		3.03	Mean		2.32

Discharge measurements of Los Angeles River at weir E.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	5.55	5.55	May 15	5.45	5.45
August 28	5.55		June 12	5.18	4.99
September 20	5.35	5.30	June 29	4.81	
September 26	5.25		July 12	4.80	4.80
October 25	5.99	5.99	July 27	4.80	
November 17	6.53	6.38	August 1	4.53	4.53
November 28	6.24		August 15	4.47	
December 13	6.24		August 31	4.88	
December 21	6.24	6.26	September 8	4.49	4.48
December 26	6.30		September 11	4.65	
			September 27	4.30	
			November 10	4.67	4.67
Mean		5.89	Mean		4.84

Discharge measurements of Los Angeles River at weir G.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	7.92	7.92	May 15	7.94	7.94
August 28	7.92		June 12	7.63	7.31
September 20	7.60	7.60	June 29	7.00	
September 26	7.60		July 27	6.45	6.45
October 9	7.66	8.13	August 1	6.45	6.70
October 25	8.60		August 15	6.80	
November 17	9.17	9.08	August 31	6.87	
November 28	8.99		September 8	6.72	6.90
December 13	8.90		September 11	7.00	
December 21	8.90	8.90	September 27	6.68	
December 26	8.92		November 13	6.99	6.99
Mean		8.33	Mean		7.06

Discharge measurements of Los Angeles River at weir L.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	9.08	9.00	May 15	8.85	8.79
August 28	8.93		May 23	8.73	
September 20	8.59	8.74	June 12	8.62	8.46
September 26	8.89		June 29	8.30	
October 9	8.59		July 27	7.53	7.53
October 25	9.58	9.22	August 1	7.53	7.71
October 27	9.48		August 8	7.59	
November 17	10.15	10.04	August 15	7.69	
November 28	9.93		August 31	8.02	
December 13	10.02	10.11	September 8	7.82	7.92
December 21	10.02		September 11	8.20	
December 26	10.30		September 27	7.76	
			November 10	8.34	8.34
Mean		9.42	Mean		8.12

Discharge measurements of Los Angeles River at weir H.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	11.88	12.04	May 15	11.42	11.31
August 28	12.19		May 23	11.21	
September 20	11.60	11.82	June 12	11.01	10.84
September 26	12.03		June 29	10.68	
October 9	11.60		July 27	9.96	9.96
October 25	12.66	12.31	August 1	9.96	10.20
October 27	12.66		August 8	10.16	
November 17	13.73	13.60	August 15	10.13	
November 28	13.47		August 31	10.57	
December 13	13.42	13.62	September 8	10.15	10.19
December 21	13.64		September 11	10.39	
December 26	13.80		September 27	10.03	
			November 10	10.54	10.54
Mean		12.68	Mean		10.51

Discharge measurements of Los Angeles River at weir I.

Date.	Discharge.	Average for month.	Date.	Discharge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	1900.	*Sec.-feet.*	*Sec.-feet.*
August 14	17.18	17.04	May 15	16.25	16.15
August 28	16.91		May 23	16.05	
September 20	17.15	17.23	June 12	15.66	15.57
September 26	17.32		June 29	15.49	
October 9	17.19	17.76	July 12	15.58	15.16
October 25	18.33		July 27	14.74	
November 17	19.04	18.88	August 1	14.37	14.70
November 28	18.72		August 8	14.94	
December 13	18.93	18.96	August 15	14.69	
December 26	18.99		August 31	14.80	
			September 8	14.54	14.53
			September 11	14.74	
			September 27	14.31	
			November 10	14.92	14.92
Mean		17.97	Mean		15.17

Discharge measurements of Los Angeles River at weir J.

Date.	Discharge at No. 7, or No. 7B + 2.49.	Discharge over weir.	Total discharge for weir.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
August 14	18.59	0.55	19.14	18.76
August 28	17.90	.49	18.39	
September 20	17.90	.49	18.39	18.58
September 26	18.28	.49	18.77	
October 9	18.08	.44	18.52	18.91
October 25	17.45	1.85	19.30	
November 17	18.02	2.91	20.93	20.71
November 28	13.78	6.71	20.49	
December 13	13.90	6.34	20.24	20.31
December 26	13.66	6.73	20.39	
Mean				19.45
1900.				
May 15	20.09	1.39	21.48	19.76
May 23	16.37	1.67	18.04	
June 12	19.81	.86	20.67	18.92
June 29	16.31	.86	17.17	
August 15	18.49	.41	18.90	19.31
August 31	19.25	.46	19.71	
September 8		.42		
September 11	19.81	.52	20.33	19.15
September 27	17.59	.39	17.98	
November 10	14.84	1.49	16.33	16.33
Mean				18.69

NOTE.—Total discharge of river at weir J equals discharge over weir + discharge at No. 7, or No. 7B + 2.49.

Discharge measurements of Los Angeles River at weir K.

Date.	Discharge at No. 7, or No. 7B + 2.49.	Discharge over weir.	Total discharge for weir.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
August 14	18.59	4.13	22.72	22.37
August 28	17.90	3.92	21.82	
September 20	17.90	3.91	21.81	22.06
September 26	18.28	3.98	22.26	
October 9	18.08	4.13	22.21	22.68
October 25	17.45	5.70	23.15	
November 17	18.02	6.97	24.99	24.73
November 28	13.78	10.69	24.47	
December 13	13.90	10.69	24.59	24.58
December 26	13.66	10.92	24.58	
Mean				23.26
1900.				
May 15	20.09	4.94	25.03	23.17
May 23	16.37	4.94	21.31	
July 2	16.32	2.93	19.25	19.25
August 1		2.55		
August 15	18.49	2.71	21.20	21.50
August 31	19.25	2.55	21.80	
September 8		2.81		
September 11	19.81	2.80	22.61	21.35
September 27	17.59	2.50	20.09	
November 10	14.84	4.12	18.96	18.96
Mean				20.85

NOTE.—Total discharge of river at weir K equals discharge over weir + discharge at No. 7, or No. 7B + 2.49.

Discharge measurements of Los Angeles River at bridge P.

Date.	Discharge at No. 7, or No. 7B.	Discharge at bridge.	Total discharge at bridge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
August 25	18.66	20.22	38.88	38.88
September 20	17.90	19.36	37.26	38.50
September 27	18.66	21.08	39.74	
October 10	18.08	19.81	37.89	
October 25	17.45	17.62	35.07	37.16
October 28	17.45	21.06	38.51	
November 17	18.02	25.73	43.75	42.34
November 28	13.18	27.75	40.93	
December 13	13.90	31.94	45.84	43.58
December 26	13.66	27.67	41.33	
Mean				40.09
1900.				
May 15	17.60	21.22	38.82	36.49
May 23	13.88	20.28	34.16	
June 12	17.32	18.59	35.91	35.91
July 2	13.83	19.51	33.34	32.16
July 12	14.00	16.99	30.99	
August 1	14.00	17.04	31.04	
August 8	14.00	18.71	32.71	33.23
August 15	16.00	19.94	35.94	
September 8		19.26		
September 11	17.32	19.67	36.99	35.23
September 28	15.10	18.38	33.48	
Mean				34.60

NOTE.—Total discharge of river at bridge P equals discharge at bridge + discharge at No. 7, or discharge at No. 7B.

Discharge measurements of Los Angeles River at bridge Q.

Date.	Discharge at No. 7-2.49, or 7B.	Discharge at bridge.	Total discharge at bridge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
September 20	15.41	28.12	43.53	43.84
September 27	16.17	27.99	44.16	
October 10	15.59	27.77	43.36	
October 25	8.21	27.66	35.87	41.31
October 28	8.23	36.48	44.71	
November 17	9.36	39.71	49.07	
November 29	12.20	33.83	46.09	47.58
December 13	11.41	35.99	47.40	
December 26	11.17	31.86	43.03	45.21
Mean				44.49
1900.				
May 15	17.60	28.42	46.02	43.93
May 23	13.88	27.97	41.85	
June 12	17.32	27.64	44.96	44.96
July 2	13.83	26.20	40.03	39.41
July 12	14.00	24.79	38.79	
August 1	14.00	24.48	38.48	38.48
September 8		27.09		
September 11	17.32	26.22	43.54	43.98
September 28	15.10	29.33	44.43	
Mean				42.15

NOTE.—Total discharge of river at bridge Q equals discharge at Q + discharge at No. 7-2.49, or No. 7B.

Discharge measurements of Los Angeles River at bridge No. 2.

Date.	Discharge at No. 7—2.49, or No. 7B.	Discharge at No. 17.	Discharge at bridge.	Total discharge at bridge.	Average for month.
1899.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*
August 19	15.59	0.06	41.29	56.94	57.79
August 25	16.17	.06	42.41	58.64	
September 20	15.41	.06	40.23	55.70	56.00
September 27	16.17	.06	40.07	56.30	
October 10	15.59	.05	39.35	54.99	
October 25	8.21	.05	48.88	57.14	55.61
October 28	8.23	.05	44.45	52.73	
October 31	8.78	.05	48.73	57.56	
November 17	9.36	.06	49.71	59.13	57.39
November 29	12.20	.06	43.40	55.66	
December 13	11.41	.07	46.69	58.17	58.15
December 26	11.17	.07	46.89	58.13	
Mean					56.99
1900.					
May 16	17.60	0.14	39.61	57.35	54.91
May 23	13.88	.14	38.46	52.48	
June 12	17.32	.14	39.23	56.69	56.69
July 2	13.83	.10	35.38	49.31	52.43
July 13	15.32	.14	40.10	55.56	
August 1	14.00	.10	34.62	48.72	
August 8	14.00	.10	34.77	48.87	51.12
August 15	16.00	.10	38.58	54.68	
August 31	16.76	.10	35.36	52.22	
September 8			34.27		
September 11	17.32	.20	35.56	53.08	51.27
September 28	15.10	.08	34.28	49.46	
November 10	14.84	.10	39.45	54.39	54.39
Mean					53.46

NOTE.—Total discharge of river at bridge No. 2 equals discharge at No. 2 + discharge at No. 7B, or No. 7 — 2.49.

Average discharge of Los Angeles River at weir No. 9.

Month.	1899.	1900.	Month.	1899.	1900.
	Sec.-feet.	*Sec.-feet.*		*Sec.-feet.*	*Sec.-feet.*
January	1.17	0.52	July	0.55	0.15
February	1.00	.49	August	.48	.18
March	1.16	.39	September	.44	.20
April	1.10	.38	October	.64	
May	.71	.30	November	.56	
June	.69	.24	December	.52	

Average discharge of developed water at weir No. 10.

Month.	1899.	1900.	Month.	1899.	1900.
	Sec.-feet.	*Sec.-feet.*		*Sec.-feet.*	*Sec.-feet.*
January		0.89	July	0.79	0.74
February		.81	August	.79	.73
March	0.96	.86	September	.83	.70
April	.93	.79	October	.86	
May	.90	.82	November	.94	
June	.86	.79	December	.91	

Average discharge of small tributary of Los Angeles River at weir M.

Month.	Discharge.	Month.	Discharge.
1899.	*Sec.-feet.*	1899.	*Sec.-feet.*
January	0.29	July	Dry.
February	.20	August	Do.
March	.20	September	Do.
April	.14	October	Do.
May	.07	November	Do.
June	.06	December	Do.

Average discharge of cut of West Los Angeles Water Company in San Fernando Valley, from gravel beds of Los Angeles River.

Month.	1899.	1900.	Month.	1899.	1900.
	Sec.-feet.	*Sec.-feet.*		*Sec.-feet.*	*Sec.-feet.*
May		5.79	September	6.02	
June		5.85	October	5.94	
July		5.75	November	6.07	
August	6.01	5.87	December	6.08	

Average discharge of Los Angeles River.

Measuring point.	Intervening distance along river.	Average discharge, August to December, inclusive, 1899.	Rate of growth per 100 feet, 1899.	Average discharge, May to November, inclusive, 1900.	Rate of growth per 100 feet, 1900.
	Feet.	*Sec.-feet.*		*Sec.-feet.*	
Weir A		0.649		0.402	
	10,280		0.001		0.001
Weir B		.723		.276	
	3,486		.066		.064
Weir C		3.06		2.52	
	7,069		.039		.033
Weir E		5.89		4.84	
	4,585		.053		.048
Weir G		8.33		7.03	
	1,041		.105		.105
Weir L		9.42		8.12	
	770		.424		.310
Weir H		12.68		10.51	
	2,543		.210		.183
Weir I		17.97		15.17	
	3,926		.038		.039
Weir J		19.45		18.69	
	3,600		.100		.060
Weir K		23.06		20.85	
	6,345		.268		.217
Bridge P		40.09		34.60	
	4,629		.096		.163
Bridge Q		44.49		42.15	
	6,756		.185		.167
Bridge No. 2		56.99		53.46	

ARROYO SECO, CALIFORNIA.

This stream is a tributary of Los Angeles River, which it joins at the city of Los Angeles. The station is described in Water-Supply Paper No. 39, page 410. During 1900 the following measurements were made at the cable station at the Terminal quarries by E. P. Dewey and W. B. Clapp:

Discharge measurements of Arroyo Seco near Pasadena, California.

Date.	Discharge.	Date.	Discharge.
1900.	*Sec.-feet.*	1900.	*Sec.-feet.*
January 3	20.3	November 21	144.0
January 4	4.3	November 22	a 580.0
March 5	7.2	Do	85.1
March 6	1.2	November 23	31.0
May 5	42.4	November 24	11.5
May 6	10.5	November 26	8.7
May 7	5.4	December 1	4.3
May 14	2.2	December 6	1.4
November 20	.2		

a Estimated.

SAN GABRIEL RIVER ABOVE AZUSA, CALIFORNIA.

This station is described in Water-Supply Paper No. 39, page 410. All of the surplus waters of the river are now used for irrigation purposes on the plain in the vicinity of Azusa, and it is only an occasional flood that passes the gaging station. Previous to 1899 it was difficult to compute the discharge of the river, owing to the location of the station and the many diversions above the mouth of the canal. In 1898, however, the San Gabriel Electric Company completed its canal system, and measurements are now obtained with greater ease and accuracy, as the conduits of the company divert the entire normal flow.

The season of 1899 and 1900 was notable in southern California for the deficient rainfall, and during the latter year only one flood discharge passed the gaging station. On November 21, 1900, a heavy rainfall prevailed in southern California, and during the night of that day the river reached 7.2 feet on the gage. The maximum discharge of this flood was computed by taking the cross section and fall of the stream and applying the Kutter formula, the coefficient of roughness (n) being obtained by comparison with a few current-meter velocity measurements. The calculated discharge was 5,168 second-feet.

The following tables are condensed from data presented in the United States Land Office suit between the San Gabriel Power Company, applicants, and irrigators in the vicinity of Azusa, Duarte, and Covina, contestants. The tables give the results of daily gagings over the weirs on various branches of San Gabriel River, as recorded by the San Gabriel Power Company. The lengths of the several weirs are as follows:

West branch of North Fork, 18-inch weir.
North branch of North Fork, 36-inch weir.
West fork of river above North Fork, 36-inch weir.
Coldwater Creek, 2¼ miles from mouth, 18-inch weir.
San Gabriel River, 100 yards above Fish Fork, 36-inch weir.
Fish Fork 100 yards above mouth, 30-inch weir.
Iron Fork 100 yards above mouth, 36-inch weir.

Estimated daily discharge, in second-feet, over weir on the west branch of North Fork of San Gabriel River, California, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1		0.23	0.19	0.20	18	0.27	0.23	0.25	
2	0.28	.23	.19	.12	19	.31	.23	.15	
3	.27	.23	.17	.18	20	.39	.22	.12	
4	.27	.26	.22	.18	21	.39	.22	.15	
5	.26	.17	.12	.23	22	.24	.22	.12	
6	.28	.23	.12	.23	23	.26	.22	.15	
7	.24	.23	.22	.19	24	.26	.22	.22	
8	.23	.22	.18	.19	25	.28	.22	.27	
9	.25	.12	.20	.19	26	.37	.23	.26	
10	.23	.12	.22	.19	27	.37	.18	.26	
11	.25	.19	.22	.19	28	.26	.18	.22	
12	.25	.19	.22	.19	29	.23	.25	.20	
13	.22	.19	.22	.22	30	.23	.20	.17	
14	.27	.19	.18		31	.23			
15	.27	.15	.18						
16	.31	.26	.12		Mean	.28	.21	.19	.19
17	.31	.23	.12						

Estimated daily discharge, in second-feet, over weir on the north branch of North Fork of San Gabriel River, California, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	.....	0.89	0.62	0.65	18	0.97	0.65	0.59	.....
2	0.92	.89	.62	.72	19	.97	.62	.59	.....
3	.92	.89	.62	.68	20	.97	.60	.59	.....
4	.92	.95	.62	.68	21	.97	.60	.53	.....
5	.89	.95	.60	.68	22	.96	.....	.53	.....
6	.89	.74	.65	.68	23	1.07	.55	.53	.....
7	.89	.74	.61	.56	24	.95	.52	.81	.....
8	.82	.74	.61	.56	25	.95	.52	.68	.....
9	.80	.77	.83	.56	26	.96	.56	.65	.....
10	.70	.77	.61	.57	27	.68	.57	.65	.....
11	.81	.74	.61	.59	28	.68	.57	.68	.....
12	.83	.74	.63	.59	29	.89	.57	.68	.....
13	.86	.77	.61	.59	30	.86	.74	.68	.....
14	.95	.68	.63	.....	31	.68	.....	.....	.....
15	.97	.74	.63	.....					
16	.97	.62	.59	.....	Mean	.89	.70	.63	.62
17	.97	.65	.59	.....					

Estimated daily discharge, in second-feet, over weir on West Fork of San Gabriel River, California, above North Fork, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	0.55	0.05	0.12	0.16	18	0.16	0.12	.11	.....
2	.62	.02	.12	.16	19	.12	.10	.12	.....
3	.68	.....	.12	.16	20	.12	.12	.12	.....
4	.62	.....	.12	.16	21	.07	.12	.16	.....
5	.53	.....	.08	.15	22	.12	.10	.16	.....
6	.55	.....	.11	.20	23	.....	.07	.....	.....
7	.55	.....	.16	.20	24	.....	.08	.....	.....
8	.55	.....	.12	.16	25	.08	.08	.12	.....
9	.44	.....	.12	.16	26	.....	.....	.20	.....
10	.34	.....	.16	.13	27	.....	.08	.16	.....
11	.29	.....	.16	.20	28	.05	.08	.16	.....
12	.26	.08	.12	.20	29	.08	.10	.13	.....
13	.24	.07	.12	.20	30	.05	.12	.14	.....
14	.20	.08	.16	.....	31	.05	.10	.....	.....
15	.13	.08	.16	.....					
16	.12	.12	.16	.....	Mean	.29	.09	.14	.17
17	.16	.10	.16	.....					

Estimated daily discharge, in second-feet, over weir on Coldwater Creek, California, 2½ miles from mouth, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	.....	0.43	0.52	.....	18	.....	0.47	.....	.....
2	.....	.....	.58	0.60	19	.....	.52	.....	.....
3	.....	.49	.62	.62	20	.....	.55	.....	.....
4	.....	.46	.57	.61	21	.....	.56	.....	.....
5	.....	.54	.55	.63	22	.....	.51	.....	.....
6	.....	.53	.56	.61	23	.....	.49	.....	.....
7	.....	.50	.51	.58	24	.....	.45	.....	.....
8	.....	.50	.51	.58	25	.....	.44	.....	.....
9	.....	.53	.56	.58	26	.....	.45	.....	.....
10	.....	.56	.50	.55	27	0.37	.42	.....	.....
11	.....	.53	.55	.60	28	.49	.42	.....	.....
12	.....	.51	.52	.60	29	.50	.41	.....	.....
13	.....	.46	.....	.64	30	.47	.40	.....	.....
14	.....	.47	.....	.....	31	.46	.56	.....	.....
15	.....	.45	.....	.....					
16	.....	.45	.....	.....	Mean	.46	.48	.55	.60
17	.....	.47	.....	.....					

Estimated daily discharge, in second-feet, over weir on San Gabriel River, California, 100 yards above Fish Fork, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	2.24			1.67	18	2.00	1.68	1.72	
2	2.48			1.67	19	1.97	1.68	1.72	
3	2.48	1.72		1.71	20	1.97	1.64	1.68	
4	2.42	1.80		1.84	21	2.00	1.68	1.59	
5	2.33	1.80		1.84	22	2.00	1.68	1.63	
6	2.27	1.80		1.80	23	2.00	1.68	1.79	
7	2.06	1.80		1.72	24	1.97	1.68	1.89	
8	2.12	1.80		1.67	25	2.18	1.76	1.84	
9	2.09	1.80	1.84	1.71	26	2.00	1.68	1.84	
10	2.15	1.80	1.80	1.71	27	2.00	1.60	1.67	
11	2.09	1.80	1.72	1.75	28	1.95	1.60	1.63	
12	2.15	1.97	1.76	1.76	29	1.77	1.68	1.67	
13	2.15	1.92	1.72	1.89	30	1.77	1.68	1.79	
14	2.03	1.85	1.76		31		1.97		
15	2.03	1.80	1.76						
16	2.12	1.68	1.80		Mean	2.09	1.75	1.74	1.75
17	2.00	1.76	1.71						

Estimated daily discharge, in second-feet, over weir on Fish Fork of San Gabriel River, California, 100 yards from mouth, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	1.42			0.95	18	1.00	0.84	0.89	
2	1.66			.90	19	1.00	.84	.86	
3	1.68	0.99		.95	20	1.00	.95	.84	
4	1.66	.96		.96	21	1.12	.89	.84	
5	1.28	1.02		.93	22	1.12	.90	.80	
6	1.25	1.06		.93	23	1.13	.90	.98	
7	1.16	1.06		.93	24	1.06	.90	1.02	
8	1.18	.92		.93	25	1.02	.92	1.01	
9	1.08	.95	1.52	.90	26	.90	.92	.98	
10	.98	1.02	.92	.89	27	.90	.92	.78	
11	.96	.99	.96	.95	28	.90	.92	.80	
12	.98	1.11	1.13	.95	29	.87	.99	.81	
13	.98	1.11	1.10	1.01	30	.87	.95	.84	
14	1.04	1.02	.99		31		1.08		
15	1.02	.99	1.08						
16	1.25	.90	.94		Mean	1.11	.96	.96	.94
17	.93	.90	.93						

Estimated daily discharge, in second-feet, over weir on Iron Fork of San Gabriel River, California, 100 yards from mouth, for 1900.

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1	1.97			1.05	18	1.37	1.09	1.09	
2	1.97	0.87		1.08	19	1.37	1.09	1.09	
3	2.03	1.05		1.05	20	1.42	1.16	1.05	
4	2.09	1.09		1.12	21	1.31	1.12	.91	
5	1.89	1.16		1.20	22	1.34	1.12	.87	
6	1.91	1.16		1.12	23	1.37	1.02	1.12	
7	1.83	.62		1.09	24	1.24	1.02	1.27	
8	1.66	1.16		1.16	25	1.29	.95	1.20	
9	1.55	1.12	1.09	1.12	26	1.24	.95	1.20	
10	1.58	1.16	1.12	1.09	27	1.26	.95	1.05	
11	1.50	1.24	1.12	1.20	28	1.21	1.02	1.01	
12	1.39	1.06	1.09	1.20	29	1.09	1.09	1.01	
13	1.42	1.09	1.09	1.23	30	1.14	1.09	1.16	
14	1.42	1.20	1.12	1.31	31	1.24	1.12		
15	1.44	1.24	1.16						
16	1.42	1.12	1.09		Mean	1.50	1.07	1.09	1.14
17	1.42	1.12	1.16						

Estimated daily discharge, in second-feet, of San Gabriel canals, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a22.0	a22.8	17.0	15.5	17.0	21.0	9.9	3.5	4.5	3.7	5.3	52.6
2	a22.0	a22.7	17.0	16.0	17.0	21.5	10.1	3.5	4.7	4.2	5.5	49.6
3	40.0	a22.6	a17.5	17.0	16.2	19.4	9.6	3.5	5.2	4.7	5.5	48.7
4	50.0	22.5	a27.5	16.0	25.0	a18.5	8.4	3.5	5.0	4.8	5.5	46.2
5	a50.0	23.0	a30.0	16.0	a48.0	18.0	8.9	4.4	4.6	4.9	5.6	44.3
6	a40.0	a22.5	a24.5	15.5	54.0	17.5	7.8	4.6	4.3	4.9	5.8	42.9
7	40.0	a22.2	a3.0	20.0	a54.0	a17.5	7.4	4.4	4.1	4.5	5.8	43.5
8	a38.0	21.8	a22.0	17.6	a49.0	a17.5	7.6	4.3	4.0	4.3	5.8	42.3
9	a34.0	21.5	21.0	16.3	a43.0	.....	7.2	4.5	4.2	4.0	5.8	35.6
10	a31.0	20.8	20.0	16.1	a43.0	17.1	6.6	4.7	4.3	4.0	5.9	35.6
11	32.0	20.6	20.0	15.0	a56.0	17.5	6.2	4.0	4.5	4.4	5.5	34.5
12	a31.0	20.5	19.5	a14.6	56.0	17.1	5.6	4.6	4.5	4.7	5.7	31.4
13	a30.0	20.4	19.3	a15.0	52.0	18.1	5.1	4.3	4.6	5.6	5.7	33.6
14	30.0	20.4	20.0	a15.0	47.0	17.5	5.1	4.5	4.8	6.4	5.9	32.9
15	a29.2	20.3	18.0	a14.6	41.6	16.0	7.2	4.1	4.5	5.8	6.2	32.3
16	a28.5	20.3	18.0	a13.5	40.3	15.4	5.9	3.9	4.1	5.3	7.1	32.4
17	a28.0	19.5	18.0	a13.5	39.0	14.3	5.6	3.7	3.7	5.2	13.4	.....
18	27.5	19.0	17.6	a13.0	a38.5	13.7	5.3	4.3	3.5	5.5	15.6	.....
19	a27.0	19.0	18.4	a13.0	a36.5	12.3	5.3	4.6	3.3	5.6	13.2	.....
20	a26.5	19.0	18.2	a14.0	a31.0	11.5	5.9	4.5	3.4	6.0	16.7	.....
21	26.0	18.7	18.1	a26.0	a30.5	11.7	5.4	4.0	3.3	5.7	b31.8	.....
22	a25.4	18.7	18.0	a22.0	a29.0	10.9	5.4	3.6	3.1	5.5	.....	.....
23	a24.8	17.5	25.0	a19.0	a30.5	10.1	4.8	3.6	3.8	5.5	.....	.....
24	a24.2	18.0	23.0	18.5	a29.5	11.0	4.6	3.6	5.2	5.8	.....	.....
25	24.5	18.0	20.0	18.5	a27.0	10.8	4.3	3.6	5.7	5.8	.....	.....
26	a24.4	18.0	20.0	19.7	a24.0	10.1	4.3	3.6	5.2	5.8	.....	.....
27	a24.3	18.0	19.5	21.0	a23.5	9.6	4.6	3.7	4.7	5.3	.....	.....
28	24.2	17.5	17.5	21.5	a22.5	9.6	4.2	3.6	4.3	5.8	45.2	.....
29	a23.8	.....	17.0	20.6	a22.0	9.1	4.9	3.5	4.2	6.2	48.0	.....
30	23.4	.....	15.5	18.5	a21.0	8.3	4.5	3.9	3.9	5.7	54.8	.....
31	23.0	.....	15.5	.....	a19.5	.....	4.1	4.3	.....	5.7	.....	.....

a Estimated. b Power conduit washed out soon after noon.

San Gabriel River at Azusa was dry throughout the year 1900—the canals diverting the entire flow—except on the dates given in the following table, and excepting also November 21 to December 31, inclusive, for which period the record is not obtainable:

Discharge of San Gabriel River at Azusa, California, 1900.

	Second-feet.
January 3	49
January 4	19
May 5	38
May 6	26
May 11	9

SANTA ANA RIVER BELOW WARMSPRINGS, CALIFORNIA.

The original station was established in June, 1896, three-fourths of a mile below the headworks of the Santa Ana canal and opposite the warm springs in the canyon. A change of location of the gage was necessitated, owing to a spillway in the canal, through which a certain amount of water from the Santa Ana flume was turned into the river below the old gage, and on November 9, 1898, a new rod was located 800 feet below the mouth of Warmsprings Canyon and 100 feet above the ford on the canyon road. The station is described in Water-Supply Paper No. 39, page 418. Results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 484.

During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

April 14: Gage height, 2.20 feet; discharge, 23 second-feet.
May 5: Gage height, 4.35 feet; discharge, 244 second-feet.
July 13: Gage height, 2.35 feet; discharge, 22 second-feet.
November 20: Gage height, 3.30 feet; discharge, 102 second-feet.

Daily gage height, in feet, of Santa Ana River below Warmsprings, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	2.20	2.23	2.20	2.64	2.33	2.26	1.85	1.85	1.95	2.00	2.50
2	2.30	2.23	2.23	2.23	2.56	2.35	2.33	1.85	1.85	1.95	2.00	2.50
3	2.36	2.23	2.23	2.33	2.50	2.30	2.33	1.85	1.90	1.95	2.00	2.45
4	2.58	2.23	2.26	2.33	2.45	2.30	2.30	1.85	1.90	1.95	2.00	2.45
5	2.53	2.26	2.40	2.33	4.40	2.33	2.30	1.85	1.85	2.00	2.00	2.45
6	2.45	2.26	2.33	2.30	a4.24	2.30	2.35	1.85	1.85	1.95	2.00	2.45
7	2.30	2.26	2.33	2.23	a4.20	2.26	2.26	1.85	1.85	1.95	2.00	2.45
8	2.26	2.30	2.33	2.20	a3.55	2.30	2.23	1.85	1.85	1.90	2.00	2.45
9	2.23	2.23	2.30	2.30	a2.90	2.26	2.20	1.85	1.85	1.90	2.00	2.45
10	2.20	2.26	2.26	2.30	2.69	2.23	2.20	1.85	1.85	1.90	2.00	2.45
11	2.30	2.26	2.26	2.26	2.55	2.23	2.23	1.85	1.85	1.90	2.00	2.45
12	2.30	2.23	2.23	2.30	a3.10	2.20	2.26	1.85	1.85	1.95	2.00	2.45
13	2.33	2.26	2.26	2.23	a2.76	2.20	2.23	1.85	1.85	2.00	2.00	2.45
14	2.38	2.23	2.26	2.30	2.60	2.26	2.30	1.85	1.85	2.06	2.00	2.45
15	2.35	2.23	2.33	2.26	2.66	2.23	2.30	1.85	1.85	2.03	2.03	2.45
16	2.23	2.20	2.26	2.23	2.65	2.20	2.23	1.80	1.85	1.95	2.03	2.45
17	2.33	2.23	2.26	2.20	2.65	2.20	2.33	1.85	1.85	1.95	2.16	2.40
18	2.23	2.23	2.23	2.16	2.60	2.20	2.33	1.85	1.85	1.95	a2.50	2.40
19	2.30	2.30	2.23	2.16	2.56	2.16	2.26	1.85	1.85	2.03	a2.90	2.40
20	2.33	2.30	2.20	2.16	2.56	2.16	2.23	1.90	1.85	1.95	3.30	2.40
21	2.30	2.23	2.26	2.50	2.58	2.23	2.03	1.90	1.85	2.00	a7.70	2.40
22	2.33	2.26	2.26	2.52	2.50	2.26	1.95	1.80	1.85	2.00	a5.10	2.35
23	2.26	2.26	2.43	2.45	2.47	2.26	2.00	1.80	1.85	2.00	4.00	2.35
24	2.26	2.26	2.37	2.40	2.40	2.30	2.00	1.80	1.90	2.00	3.75	2.35
25	2.23	2.23	2.30	2.30	2.37	2.30	1.95	1.80	2.06	2.00	3.40	2.35
26	2.20	2.23	2.30	2.40	2.35	2.30	1.90	1.80	2.00	2.00	3.20	2.35
27	2.16	2.23	2.26	2.47	2.23	2.30	1.90	1.80	1.95	2.00	3.00	2.35
28	2.20	2.23	2.23	2.50	2.20	2.26	1.95	1.75	1.90	2.00	2.90	2.35
29	2.16	.....	2.26	2.69	2.20	2.26	1.90	1.75	1.90	2.00	2.80	2.35
30	2.20	.....	2.23	2.69	2.23	2.20	1.90	1.80	1.90	2.00	2.75	2.35
31	2.20	.....	2.26	.....	2.20	.....	1.85	1.90	.....	2.00	.....	2.35

a Estimated.

MILL CREEK IN CANYON, CALIFORNIA.

This station is described in Water-Supply Paper No. 39, page 421. The Crafton Water Company diverts all of the water of the creek at the mouth of the canyon. The water passes over a weir, and the volume, therefore, is determined with considerable accuracy. The following tables, furnished by the Crafton Water Company, give the daily discharge of the creek entering the canal, as well as the amount of water which that company develops by pumping. The results of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 485.

Estimated daily discharge, in second-feet, of Mill Creek at Crafton headworks, California, for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	9.8	10.2	9.8	9.0	13.0	8.2	5.5	4.9	5.1	4.9	5.1
2	10.0	10.6	9.8	9.1	13.0	8.2	5.5	4.9	5.5	5.1	5.1
3	.....	10.0	9.8	10.0	12.1	7.6	5.6	5.1	5.5	5.1	5.1
4	.....	10.2	11.9	9.8	12.1	7.8	5.6	5.7	5.7	5.3	5.1
5	.....	10.6	10.2	9.2	.....	8.0	6.3	5.7	5.5	4.9	5.1
6	.....	10.6	10.2	9.3	.....	8.0	6.3	5.5	5.5	5.1	5.1
7	.....	10.6	10.2	9.8	15.5	8.0	5.1	5.5	5.0	5.1	5.1
8	.....	10.2	10.2	9.8	14.6	8.0	4.3	5.5	5.0	4.1	5.1
9	.....	10.6	10.2	9.7	16.4	8.0	4.3	5.1	5.0	3.8	5.1
10	.....	10.2	9.8	8.9	17.0	8.0	4.5	5.1	5.5	3.9	5.1
11	.....	10.2	9.8	8.9	.....	8.0	4.5	5.4	5.5	4.9	5.1
12	.....	10.2	9.6	9.3	.....	8.0	5.5	5.5	5.5	4.9	5.1
13	.....	10.0	9.6	9.3	.....	8.2	5.5	5.5	5.5	5.6	5.1
14	.....	10.0	9.8	8.9	.....	8.0	5.5	5.5	5.5	5.8	5.1
15	.....	10.0	9.8	8.9	.....	8.0	5.5	5.5	4.5	5.8	5.1
16	.....	10.0	9.8	9.8	12.0	8.2	4.5	5.5	4.5	5.4	8.5
17	.....	10.0	9.8	8.9	12.0	7.2	3.8	5.5	4.3	5.2	7.5
18	9.8	10.0	9.8	8.9	12.0	4.8	3.8	5.5	5.1	5.0	.....
19	10.0	10.2	9.8	8.9	13.0	6.8	4.4	5.5	4.5	5.0	.....
20	10.0	10.2	9.8	8.9	12.0	7.6	4.0	5.5	4.1	5.0	.....
21	10.6	10.2	10.2	10.2	12.0	7.6	5.4	5.5	5.1	4.1	.....
22	10.4	10.2	10.2	13.3	10.1	6.5	5.4	5.5	5.1	4.6	.....
23	10.6	10.2	13.2	10.8	12.0	6.5	4.8	4.9	4.9	5.2	.....
24	10.6	10.2	10.6	10.8	10.1	.....	5.0	5.5	5.3	5.2	.....
25	10.6	10.2	9.8	10.2	10.1	.....	5.0	4.9	5.3	5.2	.....
26	10.4	10.2	10.2	10.2	9.9	.....	5.0	4.9	5.3	5.2	.....
27	10.4	9.8	10.2	10.2	9.9	.....	5.0	4.3	4.9	5.2	.....
28	10.4	9.8	11.6	10.8	8.4	5.4	5.0	4.3	4.9	5.2	.....
29	10.4	.....	10.2	13.0	8.6	5.4	5.0	4.3	4.9	5.2	.....
30	10.6	.....	9.8	13.0	8.6	5.3	4.7	5.1	4.9	5.3	.....
31	10.2	.....	9.8	.....	8.2	.....	4.7	5.1	.....	5.1	.....
Mean	10.3	10.2	10.2	9.9	11.8	7.3	5.0	5.2	5.1	5.0	5.4

NOTE.—No record from November 18 to December 31.

Estimated daily discharge, in second-feet, of water pumped from Mill Creek at Crafton headworks, California, for 1900.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.7	2.0	2.2	3.5	2.9	2.9	2.9	2.9
2	.....	1.7	2.0	2.2	3.5	2.9	2.9	2.9	2.9
3	.....	1.7	2.0	2.2	3.5	2.9	2.9	2.9	2.9
4	.....	1.7	2.0	2.2	3.5	2.9	2.9	2.9	2.9
5	.....	1.7	.....	2.2	3.5	2.9	2.9	2.9	2.9
6	.....	1.7	.....	2.2	3.5	2.9	2.9	2.9	2.9
7	.....	1.7	.....	2.2	3.5	2.9	2.9	2.9	2.9
8	.....	1.7	.....	2.2	3.5	2.9	2.9	2.9	2.9
9	.....	1.7	.....	2.2	3.5	2.9	2.9	2.9	2.9
10	.....	1.7	.....	2.2	3.3	2.9	2.9	2.8	2.9
11	.....	1.7	2.2	2.2	3.3	2.9	2.9	2.8	2.9
12	.....	1.7	.....	2.2	3.5	2.9	2.9	2.8	2.9
13	.....	1.7	.....	2.2	3.5	2.9	2.9	2.8	2.9
14	.....	1.7	.....	2.2	3.5	2.9	2.9	2.8	2.9
15	.....	1.7	.....	2.2	3.5	2.9	2.9	2.8	2.9
16	.....	1.7	2.2	2.2	3.3	2.9	2.9	2.8	2.9
17	.....	1.7	2.2	2.2	3.2	2.9	2.9	2.8	2.9
18	.....	1.7	2.2	2.2	3.2	2.9	2.9	2.8	.....
19	.....	1.7	2.2	2.2	3.2	2.9	2.9	2.8	.....
20	.....	1.7	.....	2.2	3.2	2.9	2.9	2.8	.....
21	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
22	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
23	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
24	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
25	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
26	.....	1.7	2.2	3.7	3.2	2.9	2.9	2.8	.....
27	.....	.....	2.2	3.7	3.2	2.9	2.9	2.8	.....
28	1.0	.....	2.2	3.7	3.2	2.9	2.2	2.8	.....
29	1.5	.....	2.2	3.7	3.2	2.9	2.9	2.8	.....
30	1.7	.....	2.2	3.7	3.3	2.9	2.9	2.9	.....
31	1.7	.....	2.2	.....	3.3	2.9	.....	2.9	.....
Mean	1.5	1.7	2.2	2.7	3.3	2.9	2.9	2.8	2.9

NOTE.—No record from November 17 to December 31.

CHINO CREEK AT RINCON, CALIFORNIA.

There is no gaging rod at this place, owing to the shifting nature of the stream bed. The results of discharge measurements made during 1899 will be found in Water-Supply Paper No. 39, page 427. During 1900 the following measurements of discharge were made under the direction of J. B. Lippincott:

Discharge measurements of Chino Creek near Rincon, California.

Date.	Discharge.	Date.	Discharge.
1900.	*Sec.-feet.*	1900.	*Sec.-feet.*
January 18	24.1	August 15	1.1
January 29	27.0	September 3	a0.0
February 21	13.4	October 5	5.0
April 17	8.8	October 16	.4
June 24	4.0	November 5	14.4
July 7	2.1	December 4	17.1
July 28	2.2	December 31	16.6

a All water pumped out.

SANTA ANA RIVER AT RINCON, CALIFORNIA.

This station is described in Water-Supply Paper No. 39, page 427. During 1900 the following measurements of discharge were made at the wagon bridge at Rincon, above the mouth of Chino Creek, under the direction of J. B. Lippincott:

Discharge measurements of Santa Ana River at Rincon, California.

Date.	Discharge.	Date.	Discharge.
1900.	*Sec.-feet.*	1900.	*Sec.-feet.*
January 18	224	August 15	87
January 29	184	September 3	88
February 21	162	September 22	88
April 16	a91	October 5	c64
April 17	102	Do	74
June 24	69	October 16	122
July 7	85	October 25	b71
July 27	b38	November 5	117
July 28	c45	December 4	338
Do	61	December 31	210

a One mile below Rincon bridge.
b At Riverside Narrows, 12 miles above Rincon.
c At Auburndale bridge.

Discharge measurements of canals diverting water from Santa Ana River near Rincon, California.

Date.	Canal.	Locality.	Discharge.
1900.			*Sec.-feet.*
July 28	Newberry	Auburndale bridge	5.5
Do	Ditch south of Newberry	do	2.3
Do	Gilliland	do	1.4
August 15	Santa Ana	First road crossing	25.7
Do	Yorba	Opposite first road crossing	14.0
Do	Anaheim	do	18.4
September 3	Santa Ana	First road crossing	39.0
Do	Yorba	Opposite first road crossing	21.5
Do	Anaheim	do	18.2
September 22	Santa Ana	First road crossing	44.7
Do	Yorba	Opposite first road crossing	17.3
Do	Anaheim	do	16.7
October 5	Townsend or Newberry	Auburndale bridge	5.8
Do	Fuller	1 mile north of Auburndale bridge	6.5
October 16	Santa Ana	First road crossing	58.0
Do	Yorba	Opposite first road crossing	21.1
Do	Anaheim	do	30.0
November 5	Santa Ana	First road crossing	71.1
Do	Yorba	Opposite first road crossing	16.1
Do	Anaheim	do	29.0

SAN LUIS REY RIVER, CALIFORNIA.

The water of this river is diverted, upon its appearance from the canyon, by the flume of the Escondido Irrigation District, and is conducted to a reservoir from whence its waters are distributed for irrigation purposes. Table of the daily discharge of the river for 1899 will be found in Water-Supply Paper No. 39, page 429; that for 1900 was not available at time of publication. Measurements are made over a weir at the headworks of the canal of the Escondido Irrigation District, from whom the figures are obtained.

SWEETWATER RIVER AT SWEETWATER DAM, CALIFORNIA.

Owing to the severe drought of the last few years, the water supply of the streams of southern California, particularly of Sweetwater River, has been abnormally low. During the season 1899–1900 there was no discharge into Sweetwater reservoir from the drainage area of 186 square miles. The estimated discharge for the three preceding seasons, also table of the evaporation at Sweetwater dam, will be found in Water-Supply Paper No. 39, page 430.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN CALIFORNIA.

During the severe drought of 1898 measurements were instituted to ascertain the low-water flow of the important irrigation streams of California, the results of measurements made during that season being printed in Water-Supply Paper No. 28, page 193. These low-water measurements were continued in 1899 and 1900, the results for the former year being printed in Water-Supply Paper No. 39, page 432; those for the latter year, which were made under the direction of J. B. Lippincott, resident hydrographer, are published herein. The meas-

urements made in Sacramento and San Joaquin valleys during the three seasons mentioned have been assembled in the following table:

Miscellaneous discharge measurements in Sacramento and San Joaquin valleys, California.

Date.	Stream.	Locality.	Discharge.		
			1898.	1899.	1900.
			Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*
September 13.	Sacramento River	Jellys Ferry	4,152.00	4,087.00	
September 20.	do	do			4,105.00
September 22.	Stoney Creek	300 feet below Bridgeport bridge (1 mile below Elk Creek).			7.70
September 18.	Feather River	One-half mile above Oroville bridge.			1,123.00
October 7	Yuba River	Dry except for water from reservoir.	0.00		
August 28	do	Parks Bar Bridge, 1 mile below Smartville.			a 474.00
August 29	North Fork of Yuba River.	Above Yuba Power Company's dam.			a 282.00
September 18.	Middle Fork of Yuba River.	Freeman's bridge			a 64.00
September 17.	Bear River	1 mile south of Wheatland			12.00
October 7	American River	North and Middle forks at head of North Fork ditch.	16.00		
September —.	do	Folsom	34.50		
September 16.	do	Main stream 1 mile above mouth of South Fork.		86.10	
Do	do	North Fork ditch at road crossing 2¼ miles above Folsom.		19.64	
September 14.	do	Main stream 1 mile above mouth of South Fork.			235.00
Do	do	North Fork ditch at road crossing 2¼ miles above Folsom.			11.80
September 16.	South Fork of American River.			b 20.00	
Do	do	Natoma ditch		b 20.00	
September 14.	do	At iron road bridge near mouth.			80.50
Do	do	Natoma ditch, S.P.R.R. crossing 3 miles above Folsom.			35.00
September 23.	Cache Creek	At Rumsey road bridge			3.80
September 24.	do	Road bridge crossing near lower lake.			4.70
September 23.	Puta Creek	6 miles above Winter's, at Devils Gate.			4.40
September 15.	Consumne River	At bridge Jackson-Latrobe road crossing.		2.00	
Do	do	Michigan Bar ditch, Jackson-Latrobe road crossing.		2.00	
September 12.	do	At bridge Jackson-Latrobe road crossing.			1.70
Do	do	Michigan Bar ditch, Jackson-Latrobe road crossing.			3.70
September 14.	Mokelumne River	100 feet below bridge Mock Hill-Jackson road.		33.10	
September 12.	do	do			15.00
Do	do	Amador ditch, below Butte ditch.			37.00
Do	do	Butte ditch			4.80
September 14.	Calaveras Creek	Bridge San Andres-Jackson road.		0.00	
September 11.	do	do			0.00
October 6	Stanislaus River	Oakdale	49.60		
Do	do	Stanislaus and San Joaquin canal.	32.70		
September 9	do	Oakdale		88.40	
August 11.	do	do			66.00
September 6.	do	do			35.80
September 7	do	Stanislaus Water Company's canal 100 feet below head gate, 6 miles above Knights Ferry.			84.70

a Measurement by H. D. H. Connick.
b Estimated by Mr. Knight, superintendent of Folsom Power Company.

Miscellaneous discharge measurements in Sacramento and San Joaquin valleys, California—Continued.

Date.	Stream.	Locality.	Discharge.		
			1898.	1899.	1900.
			Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*
September 7	Stanislaus River	Below Stanislaus Water Company's intake.			28.00
		Total flow 6 miles above Knights Ferry.			112.70
October 7	Tuolumne River	Lagrange	82.70		
Do	do	Mining ditch	24.00		
Do	do	Turlock canal	30.00		
		Total flow at Lagrange	136.70		
September 11	do	1,000 feet below Geological Survey gaging station.		12.10	
Do	do	Mining ditch		24.00	
Do	do	Turlock canal flume No. 3		28.90	
		Total flow at Lagrange		65.00	
August 11	do	Lagrange			17.00
Do	do	Mining ditch			12.00
Do	do	Turlock canal			117.00
		Total flow at Lagrange			146.00
September 8	do	1,000 feet below Geological Survey gaging station.			10.90
Do	do	Mining ditch			9.00
Do	do	Turlock canal			35.00
		Total flow at Lagrange			a 54.90
September 11	Merced River	One mile above head gate of Crocker-Hoffman canal.		35.50	
Do	do	Valley Mills ditch		4.95	
		Total flow above Crocker-Hoffman dam.		40.45	
September 10	do	One-half mile above bridge at Merced Falls (total).			63.00
September 11	do	Snelling ditch (estimated)		0.50	
September 10	do	do			2.10
September 11	do	Crocker-Hoffman canal 300 feet below head gate.		16.50	
September 10	do	Crocker-Hoffman canal at head gate.			6.50
Do	do	Merced River Mill ditch at mill.			27.10
July 28	San Joaquin River	Herndon	611.00		
September 2	do	do	328.00		
September 8	do	Pollasky, 500 feet above bridge		289.30	
Do	do	Herndon		195.60	
August 9	do	do			466.00
September 1	do	do			246.00
September 28	do	do			197.00
Do	do	Pollasky, 500 feet above bridge			187.60
September 26	Salinas River	Gaging station near Salinas			1.70
July 27	King River	Red Mountain	503.00		
August 31	do	do	243.80		
September 4	do	do		206.00	
August 10	do	do			427.00
September 4	do	do			405.00
September 27	do	do			220.00
August 31	do	Church canal check near Trimmer Springs road.	164.30		
September 4	do	do		151.10	229.20
August 31	do	Seventy-six canal at mouth of canyon.	0.00		
September 4	do	do		0.00	0.00
August 31	do	Kingsburg canal at mouth of canyon.	0.00		
September 4	do	do		0.25	0.00
Do	do	Gould canal at mouth of canyon.		2.00	84.00

a It is said that at the time of this measurement a portion of the flow of Tuolumne River was being diverted for hydraulic mining in the gravel range 45 miles above Lagrange, and that after being used the water reached Merced River.

Miscellaneous discharge measurements in Sacramento and San Joaquin valleys, California—Continued.

Date.	Stream.	Locality.	Discharge.		
			1898.	1899.	1900.
			Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*
August 31	King River	Fowler Switch canal at mouth of canyon.	0.00		
September 4	do	do		0.00	0.00
September 1	Kaweah River	One-half mile above Kaweah Irrigation and Power Company's headworks.	35.80		
September 6	do	do		40.90	
September 3	do	do			100.00
September 1	do	At iron bridge above Watumna canal headworks.	17.90		
September 6	do	do		38.30	
September 3	do	do			86.60
September 1	do	Kaweah Irrigation and Power Company's ditch.	8.50		
September 6	do	do		1.49	
September 3	do	do			8.10
September 1	do	Pogues ditch	4.50		
September 6	do	do		4.87	
September 3	do	do			6.67
Do	do	Myers ditch			1.00
Do	do	Watumna ditch at headworks.			15.00
September 1	do	North Fork at mouth	0.30		
September 6	do	do		1.12	
September 1	do	South Fork at mouth	0.00		
September 6	do	do		1.18	
September 1	Tule River	Headworks of Pioneer ditch (estimated).	6.00	13.12	
Do	do	Pioneer canal 1 mile below head gate.		8.43	
September 2	do	Headworks of Pioneer ditch			9.05
August 29	Kern River	First Point of Measurement	115.62		
September 2	do	do		99.22	
August 30	do	do			103.16

Miscellaneous discharge measurements in southern California.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
October 8	Santa Clara River	Piru Creek, Piru Land and Water Company's upper ditch.	0.80
Do	do	Piru Land and Fruit Company's lower ditch	1.26
Do	do	Piru Creek opposite lower ditch	.22
Do	do	Camulos, at head of wooden flume	10.60
Do	do	Seepage at head of wooden flume, Camulos	.78
Do	do	Road crossing below San Francisquito Creek	3.25
Do	do	East Channel	3.64
Do	do	Newhall ditch	3.35
		Total	10.24
October 9	Los Angeles River	Pacoima submerged dam	.09
Do	do	Tujunga River near headworks of Monte Vista ditch.	.19
September 17	do	Arroyo Seco, Pasadena Lake, Vineyard, Land and Water Company's pump at dry tunnel (pump runs about 4 hours per day).	.55
Do	do	Arroyo Seco, main tunnel at Devils Gate (including water from a pump on surface above head of tunnel)—	
		No. 1	2.37
		No. 2	.09
		No. 3	.52
Do	do	Richardson tunnel weir, 2,800 feet below Devils Gate weir.	.385
Do	do	Arroyo Seco, Wilson's tunnel weir, 8,000 feet below Devils Gate weir.	.187
Do	do	Sheep Corral Springs, Arroyo Seco—	
		To South Pasadena	.70
		To Pasadena (pump exhausts the supply in 12 hours).	1.24
		Total	1.94

Miscellaneous discharge measurements in southern California—Continued.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
September 18	Los Angeles River	Arroyo Seco, Painters Well steam plant	0.38
		Second plant	.44
		Total	.82
September 13	San Gabriel River	Morengo Water Company, Southern Pacific Company's Garfield station.	a 1.82
Do	do	Morengo Water Company's weir in Morengo Canyon.	a .46
Do	do	Los Robles Water Company's reservoir	a .31
Do	do	Reservoir at junction of Glenarm and Los Robles avenues, Pasadena.	a 0.068
Do	do	Graves & Bean tunnel	1.10
September 14	do	Brick kiln between Molino and Hope streets, Pasadena.	.02
Do	do	Oak Knoll Park, Pasadena	.34
Do	do	Patton tunnel, near Kewen Lake	.18
Do	do	Patton's east canyon	1.48
September 17	do	Patton's east canyon (natural flow, pump not running).	.37
Do	do	Mission ditch, Patton ranch	.20
September 14	do	Winston ranch	.56
Do	do	Shorb's ranch	a .18
September 15	do	Yoakham's ranch	a .12
Do	do	Robert Liddel's, San Pasqual and Shorb streets	a .10
Do	do	R. W. Scoville's	a .07
Do	do	Mrs. Black, San Pasqual and Craig streets	a .07
Do	do	Morningside ranch, J. P. Butler's	a .04
September 17	do	Bradbury ranch, Santa Anita and Rose avenues	a 1.44
Do	do	San Gabriel Sanitarium tunnel	a .04
September 18	do	W. A. Highland's, Rose avenue, Lamanda Park	a .10
September 19	do	Chapman ranch (2 wells, 1 artesian, pumped)	1.01
Do	do	Chapman ranch (4 wells pumped)	1.90
September 20	do	Chapman ranch (natural flow of cienaga)	.07
Do	do	Chapman ranch dairy	.72
		Total	3.70
September 20	do	Alhambra Water Co	b 2.58
Do	do	do	c .34
		Total	2.92
September 24	do	Santa Anita Canyon (natural flow)	.22
Do	do	Sierra Madre Water Co	a .145
Do	do	Remamettes, east of Sierra Madre	.09
September 18	do	Monrovia Water Co. (3 wells pumped)	3.24
September 24	do	Monrovia Canyon to Monrovia Water Co	a .428
		To Bradbury	a .116
		Total	.544
September 21	do	Duarte Mutual Improvement and Canal Co	.78
Do	do	Beardsley Water Co	.44
August 7	do	East Whittier ditch at El Monte road crossing	5.71
Do	do	Killion's pumping plant, 4 wells near El Monte	10.22
Do	do	Cameron or Sheep Creek ditch	2.46
Do	do	Rincon ditch	2.47
Do	do	Old Temple ditch	1.20
Do	do	Cate ditch near head	8.71
Do	do	Standifer ditch	14.56
Do	do	Banta ditch	15.44
		Total San Gabriel River at intake of Standifer and Banta ditches.	30.00
August 8	do	Rodriguez ditch near Old Mission	2.00
Do	do	Rio Honda or old San Gabriel under Mission bridge.	23.28
Do	do	Arroyo ditch	21.08
Do	do	Little Lake	.22

a Measurement over weir. b Weir No. 1. c Weir No. 2.

Miscellaneous discharge measurements in southern California—Continued.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
August 8	San Gabriel River	Agricultural ditch	Dry.
Do	do	Below Agricultural ditch	Dry.
August 27	do	Glendora, Azusa Irrigation Co., Massey well	1.50
Do	do	Glendora, Azusa Irrigation Co., Paine well	.90
September 27	do	Daty & Sons	1.80
Do	do	San Diemas Irrigation Co., F. D. Smith well	1.20
Do	do	Thacker well	.80
Do	do	Smith well (private)	.30
Do	do	Chapman well	.70
Do	do	Ruddock well	.50
Do	do	Artesian Belt Co., 2 wells	1.60
Do	do	Azusa city well	.20
Do	do	Walker's well	.90
Do	do	Citizens Water Co., Covina	.10
Do	do	Covina plant, Deacon well	.44
Do	do	San Diemas Canyon (natural flow)	.04
Do	do	Sparks's well	.40
		Total of San Diemas wash wells *a*	11.38
Do	do	Richards, 4 wells	1.52
Do	do	Sumner	.48
Do	do	Sheldon Bros	.30
Do	do	La Verne Land and Water Co	.70
Do	do	Rodgers	.10
Do	do	True (5 days in 30)	.16
Do	do	Rodney Soper's	.24
Do	do	Hayes and Stratton	.20
Do	do	Wallace	.16
Do	do	Mullard	.30
Do	do	Douglas and McQuilly	.76
Do	do	Norris	.30
Do	do	Williams Bros	.80
Do	do	Kulp (intermittent), south of Mesa avenue	.20
Do	do	D. Fulton	.50
Do	do	Steves	.20
Do	do	Daniels and Overholtzer	1.34
Do	do	Massey, 2 wells	.54
Do	do	Hauser Bros	.76
Do	do	Moorwaw & Son	.50
Do	do	Sleider	.88
Do	do	Rutherford & Co	.40
Do	do	New Deal Water Co	.40
Do	do	Kiser	.90
		Total of wells on Lordsburg Mesa	12.64
September 25	Santa Ana River	Frey's ranch near Spadra	1.85
Do	do	Phillips's ranch near Spadra	*b*.74
September 27	do	C. L. Lancaster, Mesa avenue, Lordsburg	*b*.559
September 26	do	Covina Irrigation Co.'s compressor pumping plant, south of Lordsburg.	3.58
September 24	do	Neuruff place, corner of Holt and San Antonio avenues, Pomona.	*b*.33
September 25	do	Pomona Land and Water Co., Garey avenue	*b* 1.28
Do	do	Consolidated Water Co., Pomona, air compressor plant.	*b* 3.34
September 24	do	Consolidated Water Co., north of Pomona College.	*b*.82
September 25	do	James Warden's place	*b*.25
September 24	do	Brundege place, San Antonio avenue, Pomona	*b*.26
September 25	do	Del Monte Water Co	*b*.96
Do	do	San Antonio Water Co.'s wells in Claremont (water goes to Ontario).	*b*.40
Do	do	San Antonio Water Co.'s wells at Indian Hill, ¼ mile north of Pomona College.	*b*.99
Do	do	San Antonio Canyon	*b c* 3.72
July 11	do	Cucamonga Land and Water Co., Cucamonga Creek, 30-inch pipe line. *a*	*c* 1.15
Do	do	Cucamonga Land and Water Co., Lone Star Spring pumping plant. *a*	*c* 1.20

a Statement by Irwin F. Daniels.
b Measurement over weir.
c From records of Pomona Land and Water Company. The discharge from San Antonio Canyon was 7.53 second-feet on September 2, 1895, and 9.02 second-feet on September 6, 1897. July 11, 1900, measurement was made of water in San Antonio Canyon by S. G. Bennett, and a discharge of 4.07 second-feet was found.

Miscellaneous discharge measurements in southern California—Continued.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
July 11	Santa Ana River	Cucamonga Land and Water Co., Y tunnel *a*	*b* 1.68
Do	do	Stowell water from 90-acre tract, west side part to Ontario. *a*	*b* 2.97
Do	do	San Antonio Water Co., Haskell well	*b* 2.13
Do	do	San Antonio Water Co., Sixteenth street pumping plant.	*b* 1.72
		Total Red Hill development, Cucamonga	10.85
Do	do	Natural surface flow of Cucamonga Creek in canyon (Iomosa Water Co.).	.90
		Developed by bed-rock tunnel	.18
		Total	1.08
August 4	do	Cucamonga Land and Water Co.. Lone Star Spring pumping plant.	*b* 1.02
March 16	do	Lytle Creek, head of McIntyre ditch	*b* .14
March 19	do	Lytle Creek, head of Whiting's ditch	*b* 1.12
March 17	do	Lytle Creek near head of Ranchero ditch	*b* .24
June 8	do	Lytle Creek at intake of Rialto canal	*b* 6.19
September 29	do	do	*b* 4.62
June 8	do	Cajon Creek Canyon in flume opposite Keenbrook station.	1.37
July 12	do	West Twin Creek in flume	.22
October 1	do	do	.16
July 12	do	East Twin Creek, Del Rosa cement canal	.62
October 1	do	do	.36
July 12	do	East Twin Creek, Kansas City Syndicate development.	.15
October 1	do	do	.17
March 15	do	City Creek, Whitlock ditch, flume across McKenzie.	.23
Do	do	City Creek, Logsdon and Farrel ditch at head	1.26
Do	do	City Creek, Daley ditch at head	.72
July 12	do	City Creek, measurement in cement canal	.16
October 1	do	City Creek at head of pipe line	.21
July 12	do	Plunge Creek at intake of ditch	*a* .34
July 13	do	Below wasteway of Santa Ana canal	22.34
Do	do	South Fork or Redlands canal, water not going over weir into North Fork or Highlands canal on account of repairs.	*a* 10.65
Do	do	Redlands tunnel	*a* .84
Do	do	Morton Canyon	*a* .09
October 2	do	South Fork or Redlands canal	*a* 6.25
Do	do	North Fork or Highlands canal	*a* 5.61
Do	do	Green Spot pipe line	*a* .12
Do	do	Redlands tunnel	*a* .85
Do	do	Morton Canyon	*a* .20
April 14	do	Mill Creek, Crafton reservoir	10.77
May 6	do	Mill Creek, road crossing Santa Ana Canyon	38.76
Do	do	Mill Creek zanja	8.49
July 13	do	Mill Creek zanja	*a* 5.35
Do	do	Mill Creek, water being pumped by Crafton Water Co. and others in Mill Creek Canyon and Yucaipe Valley.	*a* 3.44
		Total	8.79
October 2	do	Crafton Water Co's pumping plant, Mill Creek Canyon.	*a* 1.35
Do	do	At mouth of Mill Creek Canyon	*a* 7.21
		Total	8.53
July 14	do	San Timeteo Canyon ditch at Bicknell Station	1.50
March 15	do	Return water, Haws & Talmage ditch at head gate.	.00
Do	do	Return water, Rabel ditch at intake	*a* .54
Do	do	Return water, Shay or Stout ditch at head	.50
March 16	do	Return water, McKenzie ditch 250 feet below intake.	2.30
Do	do	Return water, Meeks & Daley ditch, submerged weir at intake.	*a* 13.94

a Measurement by E. T. Wright. *b* Over weir.

Miscellaneous discharge measurements in southern California—Continued.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
March 21	Santa Ana River	Return water, upper canal of Riverside Water Co. at intake.	*a* 61.94
March 15	do	Return water, Beam ditch, flume 300 feet below intake.	.68
March 21	do	Return water, Swamp ditch at first turn-out	*a* .70
June	do	Return water, Haws & Talmage ditch	.00
Do	do	Return water, Rabel ditch	.35
Do	do	Return water, Shay ditch	.40
Do	do	Return water, McKenzie ditch	1.57
Do	do	Return water, Meeks & Daley ditch	13.78
Do	do	Return water, Beam ditch	.50
Do	do	Return water, Riverside Water Co.'s upper canal.	52.94
Do	do	Return water, Riverside Water Co.'s lower canal.	7.16
March 9	do	Timber ditch at intake	.00
June	do	Timber ditch	.00
March 21	do	Gage canal at head	*a* .40
Do	do	Gage canal at Palm avenue	*a* 22.58
June	do	Gage canal at head	.29
Do	do	Gage canal at Palm avenue	22.32
Do	do	Logsdon & Farrel ditch	.49
Do	do	Whitlock ditch	.00
Do	do	Daley ditch	1.12
Do	do	McIntyre ditch	.01
Do	do	Whiting ditch	.13
Do	do	Swamp ditch	.89
Do	do	Ranchero ditch	.55
March 9	do	Ward & Warren ditch at head	2.55
June	do	Ward & Warren ditch	1.70
March 9	do	Mill flume of Riverside Water Co	2.67
June	do	do	2.17
Do	do	Mill pump of Riverside Water Co	1.88
March 9	do	Camp Carlton ditch at head	*a* 2.55
June	do	Camp Carlton ditch	2.60
Do	do	East Riverside ditch	5.38
Do	do	Colton Terrace Water Co	1.54
Do	do	City of Colton	3.21
Do	do	Bloomington flume	3.68
July 26	do	Riverside Water Co.'s upper canal in flume 150 feet above tunnel of Riverside Mesa.	43.30
July 27	do	North Riverside and Jurupa canal in flume near Beckstead's house.	14.42
Do	do	Riverside Water Co.'s lower canal	7.13
Do	do	Rubidoux ditch	8.18
Do	do	Trujillo ditch	.46
Do	do	75 feet below intake of Trujillo ditch	.44
Do	do	Evans's upper ditch	1.04
		Total flow from Santa Ana at Rubidoux ditch intake.	10.12
Do	do	Alsetrez ditch from Spring Brook, 100 feet below West Riverside bridge.	2.77
Do	do	200 feet below West Riverside bridge	1.16
Do	do	West Riverside bridge, Rubidoux Mountain	5.27
Do	do	At Riverside Narrows	38.41
September 13	do	Riverside Water Co.'s lower canal	6.69
October 19	do	North Riverside and Jurupa canal	14.05
October 25	do	Rubidoux ditch	7.80
Do	do	Trujillo ditch	.53
Do	do	20 feet below intake of Trujillo ditch	.56
Do	do	Evans's upper ditch	3.32
		Total flow from Santa Ana at Rubidoux ditch intake.	12.21
Do	do	Alsetrez ditch from Spring Brook, West Riverside bridge.	1.53
Do	do	West Riverside bridge	8.45
Do	do	Evans's ditch, West Riverside bridge	4.36
Do	do	Riverside Narrows	70.64

a Measurement over weir.

Miscellaneous discharge measurements in southern California—Continued.

Date.	Stream.	Locality.	Discharge.
1900.			*Sec.-feet.*
July 28	Santa Ana River	300 feet above Auburndale bridge	45.16
Do	do	Newberry ditch, Auburndale bridge	5.47
Do	do	Ditch south of Newberry ditch, Auburndale bridge.	2.32
Do	do	Gilliland ditch, Auburndale bridge	1.40
		Total	54.35
October 5	do	Auburndale bridge	63.90
Do	do	Townsend ditch, Auburndale bridge	5.84
Do	do	Fuller's ditch near schoolhouse	6.50
July 28	do	Rincon bridge	60.76
Do	do	Chino Creek under bridge on Chino-Corona road	2.20
October 5	do	Rincon bridge	74.20
Do	do	Chino Creek	5.00
July 28	do	Durkee ditch near ranch house	1.80
Do	do	Anaheim and Santa Ana division box	48.60
October 5	do	do	75.10
March 17	Pumping plants	East Riverside Irrigation District	6.59
Do	do	Colton Terrace Water Co	1.69
Do	do	City of Colton, upper pumps	2.57
Do	do	City of Colton, lower pumps (estimated)	2.37
Do	do	Bloomington, flume at lower end	3.80
March 21	do	Mill pump of Riverside Water Company, not running.	.00
Do	do	Pomroy & Marble, not running	.00
March 16	do	Johnson & Hubbard, two flumes	1.26
Do	do	Base line and Waterman avenue, not running	.00

Discharge measurements in tunnels near Devils Gate, Arroyo Seco, Los Angeles River, California.

Date.	Tunnel.	Discharge.
1897.		*Sec.-feet.*
June 14	Northwest tunnel	3.72
July 12	do	3.72
August 9	do	3.42
October 11	do	2.93
November 8	do	2.93
June 14	Northeast tunnel	.34
July 12	do	.296
August 9	do	.276
September 13	do	.238
October 11	do	.218
November 8	do	.256
June 14	Richardson tunnel	.726
July 12	do	.723
August 9	do	.612
September 13	do	.618
October 11	do	.318
November 8	do	.618
June 14	Wilson's tunnel	.380
July 12	do	.380
August 9	do	.318
September 13	do	.380
October 11	do	.360
November 8	do	.360

[Concluded in Water-Supply Paper No. 52.]

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DEPARTMENT OF THE INTERIOR

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UNITED STATES GEOLOGICAL SURVEY

No. 52

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1900

A REPORT OF THE

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UNITED STATES GEOLOGICAL SURVEY

PART VI

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1901

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OPERATIONS AT RIVER STATIONS, 1900.[1]

PART VI.

PRECIPITATION ON MOUNTAINS IN SOUTHERN CALIFORNIA.

In order to obtain rainfall data bearing upon river discharge, a number of rainfall gages have been established at various points in the mountainous regions of California. Results obtained at these localities during 1900, together with a few figures from other sources, are given in the following tables. The first table gives the location of the rainfall stations; the second table gives the depth of rainfall, in inches, for each month of the year. Similar figures for 1896 are given on page 418 of the Eighteenth Annual Report, Part IV; for 1897, on page 539 of the Nineteenth Annual Report, Part IV; for 1898, on page 560 of the Twentieth Annual Report, Part IV; and for 1899, on page 437 of Water-Supply Paper No. 39.

Rainfall stations in southern California.

Station.	County.	Post-office.	Latitude.		Longitude.		Elevation.
			°	′	°	′	*Feet.*
Sisson	Siskiyou	Sisson	41	27	122	25	3,555
Dunsmuir	do						
Delta	Shasta						
Redding	do						
Redbluff	Tehama	Redbluff	40	12	122	20	324
Jacinto	Glenn						
Upper Lake	Lake						
Sonora	Tuolumne	Sonora	38	00	120	16	1,824
Second Garrotte	do	Groveland	37	49	120	12	2,900
Crockers	do	Sequoia	37	48	119	53	4,453
Yosemite	Mariposa	Yosemite	37	45	119	35	4,063
Millwood	Fresno	Millwood					
Milo	Tulare	Milo	36	15	118	50	3,200
Kernville	Kern	Kernville	35	45	118	25	2,600
Isabella	do	Isabella	35	48	118	25	2,600
Taylor's ranch	do	Weldon	36	20	118	17	2,640
Mount Breckenridge	do	Bakersfield	35	25	118	35	6,750
Bear Valley	do	Tehachapi					4,000
Tejon ranch	do	Bakersfield	35	00	118	45	1,450
Fort Tejon	do	Lebec	34	53	118	53	3,245
Frazier mine	Ventura	Neenach	34	49	118	58	3,000
La Liebre	Los Angeles	do	34	46	118	40	3,170
Sneddens	Ventura	Griffin	34	41	119	03	4,900
Smith's ranch	do	Gorman	34	44	118	47	4,850
Palmdale headworks	Los Angeles	Palmdale	34	25	118	03	3,299
Mutah Flat	Ventura	Griffin	34	38	119	03	4,850
Magic Hill	Los Angeles	Burbank	34	23	118	22	2,820

[1] Continued from Water-Supply and Irrigation Paper No. 51.

Rainfall stations in southern California—Continued.

Station.	County.	Post-office.	Latitude.		Longitude.		Elevation.
			°	′	°	′	*Feet.*
Colby's camp	Los Angeles	Pasadena					3,875
Mount Sister Elsie	do	Monte Vista	34	17	118	14	5,021
Mount Lowe	do	Echo Mountain	34	15	118	07	3,200
Follows's camp	do	Azusa	34	14	117	49	1,800
Glenn ranch	San Bernardino	Cajon	34	50	117	30	3,112
Upper Holcomb	do	San Bernardino	34	18	116	50	7,200
Little Bear Valley	do	do	34	15	117	10	5,150
Morse's house	do	do	34	12	117	12	5,350
Deep Creek	do	do	34	17	117	05	5,200
Holcomb Creek	do	do	34	18	116	58	5,220
Squirrel Inn	do	do	34	12	117	12	5,300
Santa Ana River power house	do						
Mill Creek (a)	do	Redlands					5,000
Mill Creek (b)	do	do					2,915
Descanso	San Diego	Descanso	32	50	116	40	3,500
Campo	do	Campo					2,060
Laguna	do	do					5,700
Cuyamaca	do	San Diego	32	58	115	35	4,800
Sweetwater dam	do	National City	32	43	117	00	250
La Mesa							

Precipitation at rainfall stations in southern California, 1900.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Sisson	8.64	1.04	9.92	3.49	2.05	1.24	0.00	0.16	0.67	10.76	4.52	3.80	46.29
Dunsmuir	9.93	3.32	6.27	4.85	3.18	.90	0.00	T.	1.20	6.13	7.16	8.29	51.23
Delta	12.25	4.60	9.45	8.59	4.10	1.56	.17	.20	.97	15.68	10.51	8.04	76.12
Redding	6.45	2.86	3.68	2.59	3.12	1.38	T.	.16	2.48	6.47	3.03	3.14	35.36
Redbluff	4.15	1.62	2.38	2.69	1.18	.94	0.00	.05	.21	3.25	3.23	2.07	21.77
Jacinto	3.06	.17	1.27	1.68	.72	0.00	0.00	0.00	0.00	2.42	5.00	.....	.....
Upper Lake	3.98	1.31	3.53	2.13	.81	.35	T.	0.00	.03	3.96	5.08	3.63	24.81
Sonora	3.20	1.37	2.75	4.28	2.01	.20	0.00	.03	.14	5.10	10.29	2.05	31.42
Second Garrotte	5.25	1.25	3.75	4.00	1.50	0.00	0.00	0.00	.25	5.00	14.00	1.50	36.50
Crockers	5.98	1.18	4.28	3.56	1.80	.47	0.00	0.00	.62	9.71	17.43	1.39	46.42
Millwood	.....	.....	.....	.....	.....	.....	.....	.....	1.50	6.70	10.37	(a)	.....
Kernville	.80	.53	.58	.52	.90	0.00	0.00	0.00	.79	.10	5.09	0.00	9.31
Isabella	1.10	.65	.65	.73	1.06	0.00	0.00	.02	.30	.24	5.53	.05	10.33
Taylor's ranch	.71	.47	.50	.39	.82	.02	0.00	.03	.62	.02	4.29	0.00	7.87
Bear Valley	2.77	1.34	1.00	5.05	2.47	0.00	0.00	0.00	0.00	1.76	2.71	.32	17.42
Tejon ranch	1.17	.35	.41	1.97	1.57	.02	0.00	0.00	.06	.67	1.06	.34	7.62
Fort Tejon	2.12	.66	.85	1.82	1.57	0.00	0.00	0.00	1.06	0.00	1.71	.50	10.29
Sneddens	1.40	T.	1.45	.50	1.40	0.00	0.00	0.00	0.00	0.00	4.52	0.00	9.27
Smith's ranch	1.20	0.00	1.12	.12	.75	0.00	0.00	0.00	.15	0.00	3.10	0.00	6.44
Palmdale headworks	.65	0.00	.80	.57	.76	0.00	0.00	0.00	0.00	.20	1.79	0.00	4.77
Mutah Flat	2.80	0.00	1.95	.40	1.80	0.00	0.00	0.00	0.00	0.00	5.10	0.00	12.05
Magic Hill	1.34	0.00	1.67	2.05	4.40	.06	.04	0.00	.54	.71	6.53	0.00	17.34
Colby's camp	1.15	0.00	2.00	1.38	3.25	0.00	0.00	0.00	.25	.45	8.15	0.00	16.63
Mount Sister Elsie	.85	0.00	1.87	1.30	3.02	0.00	0.00	T.	.09	.31	6.70	0.00	14.64
Mount Lowe	.....	.....	2.90	2.15	4.05	.40	T.	0.00	.25	1.66	11.71	0.00	.....
Follows's camp	.....	T.	2.40	1.77	2.98	.....	.....	.....	.....	.....	.....	.....	.....
Glenn ranch	2.15	.10	3.84	1.35	1.69	.02	.01	0.00	.31	.46	9.39	0.00	19.32
Little Bear Valley	1.39	.43	3.42	3.11	4.63	.....	.....	.....	.....	.....	.....	.....	.....
Morse's house	2.20	.44	3.83	5.81	8.64	.....	.....	.....	.....	.....	.....	.....	.....
Deep Creek	1.40	.28	3.07	2.70	4.75	.....	.....	.....	.....	.....	.....	.....	.....
Holcomb Creek	.38	.21	1.14	1.25	1.20	.....	.....	.....	.....	.....	.....	.....	.....
Squirrel Inn	1.73	.26	3.04	4.81	6.37	.....	.....	.....	.....	.....	.....	.....	.....
Santa Ana River power house	.10	0.00	2.38	5.49	3.70	0.00	0.00	0.00	.98	.74	8.26	0.00	21.65
Mill Creek (a)	2.52	.43	2.28	4.49	.....	.....	.....	.....	.....	.....	9.05	.....	.....
Mill Creek (b)	1.41	.07	1.43	3.74	3.31	0.00	0.00	0.00	1.14	1.15	4.96	0.00	17.21
Descanso	4.00	.75	1.25	4.25	2.69	.06	0.00	T.	.25	.63	6.50	.15	20.53
Campo	2.65	.10	.55	2.07	1.04	.10	0.00	0.00	.05	.28	4.47	0.00	11.31
Laguna	3.30	.37	1.00	3.80	2.19	.30	0.00	0.00	.20	.40	6.20	0.00	17.76
Cuyamaca	3.62	.26	2.51	6.69	2.81	.10	.28	0.00	.92	.74	11.97	.04	29.94
Sweetwater dam	.57	0.00	.37	1.06	1.66	0.00	0.00	0.00	0.00	.25	1.63	0.00	5.54
La Mesa	.97	.03	.72	1.73	1.53	T.	T.	0.00	.01	.37	2.38	0.00	7.74

a Gage destroyed.
T indicates trace of rainfall.

CONSTRUCTION OF WELLS IN SOUTHERN CALIFORNIA.

Mr. H. N. Savage, of National City, California, states that in constructing wells in sand and small gravel he puts down a tube 3 inches in diameter, open at the bottom, the lower portion being perforated and wound with wire spaced 1 inch between coils. Around this wire is wrapped a wire gauze with 50 meshes to the lineal inch, and outside of this the wire is again wound, strips placed longitudinally to the pipe being soldered to each turn of the wire. The pipe with this perforated tube on the lower end is sunk by forcing muddy water down it, lengths being added as the pipe descends. It has been found that clear water can not be used successfully, but that a considerable amount of silt must be kept in suspension in the wash water. Presumably the sediment serves to coat the sand and prevent its adhering to the outside of the pipe.

In adding new joints to the top of the pipe, the change is made with great rapidity, so as not to shut off the wash water for more than a few seconds. If the water is stopped for a longer period the sand will settle against the pipe and prevent further progress. When the pipe has been settled into position, gravel is immediately shoveled around it, while the water is still rising on the outside. About one-half cubic yard of gravel is thus shoveled in. As soon as this is done pumping is started, to clean out the well. A centrifugal pump is used for the purpose. At first it is necessary to prime the pump often, sometimes every few minutes. Pumping is continued until the sand is exhausted—sometimes several days or a week is required to accomplish this. The top of the pipe is then connected to the permanent pump, no inside tubing being used.

Several hundred wells, most of them about 50 feet deep, have been driven by Mr. Savage by the common sand-pumping process, 5-inch pipe in 10-foot lengths being used for casing, the sand being pumped out as the casing is forced down to good water-bearing material. A strainer, usually made of 3-inch pipe covered with punched brass or with wire gauze, is put down inside of the casing, with a 2-inch pipe extending to the surface of the ground. The annular space between the interior of the casing and the exterior of the strainer and suction pipe, extending to the surface of the ground, is filled with coarse sand, and the casing is withdrawn.

Usually the supply is from a gang of 30 or 40 wells. Centrifugal pumps are used exclusively, generally horizontal compound, discharging with good efficiency into the main pipe line against a head of 50 to 60 pounds pressure per square inch.

Ten of these pumping plants have been installed by Mr. Savage for the San Diego Land and Town Company, and he makes the following statements in regard to them and to the wells which they serve:

The wells are in a valley of recent sedimentary deposits, consisting of uneven and irregular (a few inches to a few feet thick) strata of water-bearing, sandy silt, separated by similar strata of impervious, clayey silt. The best results—

economy of installation, yield of water, and duration of supply—have been obtained from wells about 50 feet apart, connected to main suction lines having a pronounced grade away from the pump. The wells were put down by first sand pumping through 5-inch standard screw pipe, cut into lengths of about 10 feet, a sand pump or bucket with jar and rods being used. The bucket is made of 4-inch (outside diameter) casing pipe about 6 feet long. The first section of 5-inch pipe being started, a lever is clamped to it. This serves also as a platform upon which the men stand while working the sand pump, and when the pipe is being turned with the lever their weight assists in forcing it into the ground. Additional lengths of pipe are put on as required, and the operation is continued until water-bearing sand of sufficient coarseness and thickness of strata is found, when the strainer, with sufficient pipe to reach from the bottom of the well to the top of the ground, is inserted within the 5-inch pipe. The annular space between the 5-inch pipe and the outside of the strainer with its pipe extension is filled with coarse sand or gravel, after which the outer or 5-inch pipe is withdrawn.

The strainer is made of a piece of 3-inch pipe from 2 feet to 4 feet long (depending upon the fineness of the sand-bearing stratum), perforated with ½-inch holes spaced from 1 inch to 1½ inches between centers. No. 12 B. W. G. wire is wound spirally over the perforated section (the spirals being spaced about 1 inch apart), which then is covered with a sheet of thin brass punched full of holes about $\frac{3}{32}$ inch in diameter. The punch was specially designed for this work. It has 24 points (four rows of six in a row), and one blow of the hammer is sufficient, the sheet being placed on a wood block. The punch makes either a cone or pyramidal truncated indenture through the sheet, which, when wrapped and soldered around the perforated pipe, gives a first-class strainer. The diameter of the holes punched in the brass sheet is reduced, of course, with the fineness of the water-bearing material. The holes presented to the water-bearing sand are very small, and since they increase in diameter toward the pipe, any material fine enough to enter does so without obstructing the opening. We use a 2-inch pipe extending from the strainer to the top of the ground.

As each well is completed a No. 6 Douglas hand pump is connected to the top, and it is thoroughly pumped, to free it from clayey matter and fine sand. Formerly we tested each well with a gasoline-actuated centrifugal pump, and left the bottom of the strainer pipe open. We have found it desirable, however, to plug the bottom of the strainer before putting it into the well, which of course decreases its capacity somewhat, but is imperative in quicksand formations. These wells yield 8 or 10 miners' inches each.

We are obtaining remarkably satisfactory results from horizontal centrifugal pumps, either single or compound, actuated by gasoline engines. I have just completed a plant, the supply of which is from a small gang of wells, which is operated by a No. 3 horizontal compound centrifugal pump actuated by a 22-horsepower gasoline engine, the water being discharged into the Sweetwater distributing system against 60 pounds pressure. When last measured the plant was developing a fraction more than 29 miners' inches.

There are numerous "tricks" connected with the installation and operation of these plants, both in sinking the wells and in operating the machinery, any one of which, we have found to our annoyance, would either make or break the success of the undertaking.

IRRIGATION IN UTAH VALLEY, UTAH.[1]

INTRODUCTION.

During the latter half of the month of August, 1899, data were obtained for a brief report on the irrigation systems of Utah Valley.

[1] Report of J. S. Baker.

Information regarding the history, the area irrigated, etc., was given by the presidents and directors of canal companies, by water masters, and by those most closely connected with irrigation along the various streams. In many cases the statements were from memory, although in most cases they were from records. Frequently it was necessary, owing to lack of time in which to make observations, to accept approximate estimates from those who contributed the information. In view of these facts the data are necessarily incomplete and in some cases are inaccurate, but they give, in a general way, the facts as they existed.

Utah Valley is in the north-central portion of the State, between the high Wasatch Range on the east and the low Lake Mountains on the west. There are about 150,000 acres of irrigable land in Utah County, most of it in Utah Valley. In 1890 there were 40,195 acres cultivated, and 36,586 acres irrigated; in 1899 there were about 65,000 acres irrigated. Utah Lake occupies, when at a mean elevation or "compromise line," about 84,000 acres in the northwestern part of the valley. The agricultural land lies along the eastern and southern sides. The upper lands consist of gravel, sand, and loam, while the lower lands bordering the lake are sandy loams and in many places adjacent to the lake are marshy.

Water for irrigation is supplied by Provo River, Spanish Fork, American Fork, Hobble Creek, Peteetnetr Creek, Current Creek, Summit Creek, Rock Canyon Creek, Goshen Warmsprings Creek, Salem Pond, Smith Brothers' spring, Mapleton Union or North reservoir, South Mapleton reservoir, and Mount Nebo reservoir. The principal facts in regard to these sources of supply are given in the following table and on succeeding pages:

Streams irrigating lands in Utah Valley in 1899.

Name of stream.	Drainage area.	Length.	Measurement.		Number of canals diverting water.	Area irrigated.
			Date.	Discharge.		
	Sq. mi.	*Miles.*	1899.	*Sec.-ft.*		*Acres.*
Provo River	1,000	90	June 29	1,745	16	*a* 20,000
Do			July 13	535		
Do			Aug. 16	340		
Spanish Fork	670	45	Aug. 22	139	5	17,708
American Fork	66	18	May 9	131	3	*a* 15,000
Do			Aug. 25	57		
Hobble Creek	160	25	Aug. 21	47	7	5,250
Peteetnetr Creek	30	10	May 1	21.3	17	1,400
Do			May 15	121.8		
Do			June 1	65.2		
Do			June 15	29.7		
Do			July 1	23.3		
Do			July 15	21.3		
Do			Aug. 1	17.0		
Do			Aug. 15	15.6		
Current Creek	12	12			7	2,500
Summit Creek		8	Aug. 23	14.6	*b* 8 to 14	1,200
Rock Canyon Creek			do	*a* 4.0		400
Goshen Warmsprings Creek			do	5.5	3	825
Spring Lake Creek			do	2.9		150
Salem Pond			Aug. 22	5.0	1	600
Smith Brothers' spring			Aug. —	.9		*c* 40

a Approximate.
b Some canals discontinue in low-water season.
c Orchard and vineyard.

The methods of irrigation throughout the entire valley are flooding for small grains and grasses and the furrow method for orchards and vegetables. The water is distributed on a time basis.

PROVO RIVER.

Provo River is the largest stream entering Utah Valley. It has its source in the summit of the Uinta Mountains, on the boundary line between Summit and Wasatch counties, and very near the sources of Bear, Weber, and Duchesne rivers. For about 18 miles it flows through a precipitous canyon, which in cases of heavy rainfall yields a large run-off. The river is therefore subject to great fluctuation. At the upper end of Provo Canyon is a large valley of the same name. This valley is useful to the lower irrigators as an underground storage reservoir. A part of the water of the river is applied to the land of the valley during the early part of the season, and reaches the river again by seepage shortly after the commencement of the low-water period, thus increasing the flow during that season. Indeed, it has been suggested by the people of Provo that the irrigators of the upper valley be paid to irrigate the uncultivated lands of that valley so as to still further increase, by seepage, the flow of the river below at a time when water is most needed. Since 1883 there have been but four years in which Provo River has carried a sufficient quantity of water to supply the needs of the irrigators below.

The water of the river is allotted as follows: Blue Cliff canal, Timpanogas canal, Provo Bench canal, one-eighth; Roberts's ditch, Park & Nuttall's ditch, Bomb & Richardson's ditch, Richmond & Penrod's ditch, Stubbs & Furgeson's ditch, West Union canal, two-fifteenths; Upper East Union canal, one-twelfth; Lake Bottom canal, one-fifteenth; East Union canal, Factory race, City race, and Tanner's, forty-three hundredths; and Little Dry Creek canal, one-fifteenth.

Blue Cliff canal.—This is the first canal diverting water from Provo River. It heads about 2½ miles above the mouth of Provo Canyon, on the north side of the stream. The greater part of it was built by the labor of the owners, but small portions were built under contract. In connection with this canal there is contemplated a reservoir on Provo Bench, three-fourths of a mile northwest from the mouth of Provo Canyon, with an area of 20 acres, a depth of 10 feet, and a capacity of 200 acre-feet.

Timpanogas canal.—This is the second canal diverting water from the river. It was built entirely by the labor of the appropriators. Measurements made July 9, 1897, by the water commissioner, Mr. A. L. Booth, of Provo, show a discharge of 7.27 second-feet. An annual tax of 50 cents per share, to pay the water master and general expenses of operating, is levied on the stock of the company. Considerable trouble has been experienced by frequent breaks in the embankment, which have deprived the irrigators of the use of water for a considerable length of time. Measurements for seepage loss were made August 16, 1899, one near the head and one 9,500 feet below. At the upper point the discharge was 10.40 second-feet; at the lower point it was 7.83 second-feet, showing a loss of 2.57 second-feet,

or 24.6 per cent of the discharge at the head. This is equal to a loss of 2.6 per cent per 1,000 feet.

Provo Bench canal.—This is the third canal diverting water from the river. It heads near the mouth of the canyon, on the west side of the stream. The diverting dam is made of two large logs buried to their tops, horizontally, in the bed of the stream, at right angles to the current. The lower log, which is 10 feet farther downstream, is the higher. On top of the logs planks are spiked transversely. An apron of 2-inch plank extends from the crest of the dam 20 feet downstream. On top of the crest and extending along it is a plank 10 inches high, placed on edge. The gates are two in number, each 7 feet high, 6 feet wide, and of 2-inch plank. They are operated by a rack and pinion and hand lever. The original water rights were acquired by appropriation, but later the canal was enlarged and water to fill it was purchased. Measurements for seepage on this canal were made August 17, 1899. The loss from that source and from evaporation was 4.31 second-feet (equal to 7.4 per cent of the amount at the head) in a distance of 1.5 miles. There are five small ditches diverting water from the river and from what is known as City Creek. Two of them—Roberts's ditch and Park & Nuttall's ditch—are on the west side of the river, and three of them—Bomb & Richardson's, Richmond & Penrod's, and Stubbs & Furgeson's—are on the east side of the river. Measurements of these ditches were made August 17 and 18, 1899, the results of which are given in the table on page 503.

West Union canal.—This canal is the fourth one diverting water from Provo River. It heads 1 mile below the mouth of Provo Canyon, on the west side of the stream. It was constructed in 1875–76 by day labor. In 1897 the West Union Canal Company consolidated with the Enterprise Canal Company under the name of the East Union Canal Company, and the canal was enlarged so as to carry the supply of both companies. The water has a rental value of $2 per share per annum. Measurements made on July 9, 1897, showed a discharge of 29.3 second-feet, and those made on August 4, 1897, a discharge of 30.6 second-feet. The interest in the canal is separate from that in the land; water rights do not go with the land, but are bought and sold as other property. Each owner can sell or rent his proportion of the water if he does not care to use it, but if he does not sell or rent it the company can do so and the revenue goes into the treasury of the company.

Upper East Union canal.—This is the fifth canal diverting water from the river, and the uppermost from City Creek, an old river channel through which irrigation water for the city of Provo is taken to the four canals serving it. The construction of the Upper East Union canal was begun in 1871 and was completed in 1874. It was built by day labor of the appropriators and by contract. The water rights were acquired by original appropriation. One share of stock in the company covers the right to the use of enough water to irrigate 1 acre of land. The canal was designed to carry 30 second-feet of water. On July 9, 1897, there were 32.35 second-feet flowing in it, and on August 4, 1897, 21.45 second-feet. Measurements made in 1899 will be found in the table on page 503. The loss in seepage on August 17, 1899, in a distance of 1 mile, was 0.75 second-foot, or 2.65 per cent of the amount at the head of the canal.

Lake Bottom canal.—This is the sixth canal diverting water from the river, and the lowest from the west side. It is taken out about 4 miles below the mouth of Provo Canyon. It was constructed in 1861, by the labor of the appropriators. Measurements were made July 9, 1897, near the head of the canal, and showed a discharge of 15.78 second-feet; those made August 4, 1897, showed a discharge of 12 second-feet. A large amount of water seeps into this canal from the irrigated land above, which consists of a deep gravel deposit. Being supplemented by seepage water it is not so subject to shortage as are the canals above.

East Union canal.—This is the seventh canal diverting water from Provo River. It is supplied through City Creek. It is nearly parallel to the Upper East Union canal, at an average distance of five-eighths of a mile. It was constructed in 1857, by the labor of the appropriators. The capacity was designed to be 27 second-feet. In 1874, upon the petition of the owners, the canal was placed under the control of the city of Provo, for the reason that most of the land under it was within the city. The water rights are valued at from $60 to $70 per acre for farms and $125 per acre for city lots.

Factory race.—This race is the eighth canal diverting water from the river. It is supplied through City Creek. It was enlarged in 1872, when an additional amount of water was appropriated. Its capacity is about 67 second-feet. Like the East Union canal, it was placed under municipal control in 1874. About three-fifths of the water of this canal is used by the Provo mills for power purposes; the remainder is used for irrigation.

Tanner's race.—This is the tenth canal diverting water from the river. Some of the water is used for power purposes, but after having passed the mills it is again used for irrigation. The capacity of the canal is about 27 second-feet. It was taken under the control of the city of Provo in 1874.

Little Dry Creek canal.—This is the last and the oldest canal diverting water from Provo River. Its headworks are near the northwestern part of the city of Provo. It was constructed in 1852, by the labor of the appropriators. On July 9, 1897, a measurement was made which showed a discharge of 12.5 second-feet; on August 4, 1897, another measurement was made which showed a discharge of 8.8 second-feet. Measurement made in 1899 will be found in the table on page 503.

Data regarding Provo River canals.

Name of canal.	Year of appropriation.	Capital stock.	Number of shares.	Value of shares.	Dimensions of canal.		
					Length.	Width.	Depth.
					Miles.	*Feet.*	*Feet.*
Blue Cliff canal *a*	1884	$50,000	2,000	$25	7	6	2
Timpanogas canal	1878	4,125	165	25	6		
Provo Bench canal	1866				9.5		
Roberts's ditch *b*							
Park & Nuttall's ditch *b*							
Bomb & Richardson's ditch *b*							
Richmond & Penrod's ditch *b*							
Stubbs & Furgeson's ditch *b*							
West Union canal	1876	24,000	1,200	20	10		
Upper East Union canal	1872	17,220	1,722	10	7.5		
Lake Bottom canal	1858				7		
East Union canal *c*	1857				5.5		
Factory race	(*d*)				4.5	12	3.5
City race *c*					5		
Tanner's race *c*	1856				6		
Little Dry Creek canal	1852	4,000	400	10	4		

a In course of construction.
b Data not ascertained.
c Under control of city of Provo.
d Time of first appropriation not learned; second appropriation in 1872.

Duty of water of Provo River canals in 1899.

Name of canal.	Measurements.		Length of irrigation period.	Duty of water.			
	Date.	Discharge.		Area irrigated.	Amount used.		Depth.
	1899.	*Sec.-feet.*		*Acres.*	*Sec.-ft.*	*Acre-ft.*	*Feet.*
Bluff Cliff canal *a*		41.66	Apr. 1 to Sept. 1	*b* 2,700	*b* 41.66	*b* 12,643	*b* 4.68
Timpanogas canal	Aug. 16	*c* 10.40 *d* 7.84	Apr. 15 to Sept. 15	650	7.84	2,379	3.66
Provo Bench canal	Aug. 17	53.65 *e* 57.96	Apr. 1 to Sept. 1	4,000	53.65	16,281	4.07
Roberts's ditch	do	2.80	Apr. 15 to Sept. 15				
Park & Nuttall's ditch	do	11.84	do				
Bomb & Richardson's ditch.	Aug. 18	*f* 1.00	do				
Richmond & Penrod's ditch.	do	*f* 4.00	do	*g* 1,200	10.00	3,035	2.52
Stubbs & Furgeson's ditch.	do	*f* 5.00	do				
West Union canal	Aug. 17	55.98	do	3,500	55.98	16,988	4.85
Upper East Union canal	do	*c* 28.27 *d* 27.52					
Do	May 8	29.28	Apr. 15 to Sept. 15	680			
Lake Bottom canal	Aug. 17	7.14	do				
East Union canal	Aug. 18	18.22	do				
Factory race	do	51.44	do	*h* 300			
City race	do	12.40	do	380			
Tanner's race *i*	Aug. 17	16.94	do	490			
Little Dry Creek canal	do	4.64	do	400	4.64	1,408	3.52

a Not yet completed.
b Calculated.
c Near head.
d Near laterals.
e One-half mile above first measurement.
f Float measurement.
g These three canals irrigate low land.
h Acreage reported by Walter Scott, of Provo; three-fifths of the stream used for power.
i Irrigates city property almost exclusively.

SPANISH FORK.

Spanish Fork is the second river of importance in Utah Valley. It rises near Soldiers Summit, in the tops of the Wasatch Mountains, near the eastern rim of the Great Basin. Throughout the greater part of its course it passes through a deep and narrow canyon about 30 miles in length, enters Utah Valley in the southeast corner, and thence flows in a northwesterly direction into Utah Lake. The following canals divert water from it for irrigation purposes:

East Bench canal.—This canal heads a short distance above the mouth of Spanish Fork Canyon, on the north side of the river. It irrigates the high bench east of the city of Spanish Fork.

Salem Irrigation Company's canal.—This canal heads a short distance below the East Bench canal, but on the south side of the river. It was planned in 1868, and was constructed in 1869–70, by the labor of the appropriators. Measurements are made every year at the head gate, which is 4 feet wide, and the depth varies from 17 inches down. This is all that is known by the irrigators of the amount of water flowing in the canal. As a means of keeping the canal free from sediment and aquatic vegetation, it is dredged twice each week during the irrigation season. The dredge is made of a railroad rail bent in a V shape, the distance between the two ends of the rail being equal to the width of the canal. The dredge is fastened by the apex, with the flange down, to the rear end of a cart, and is drawn down the entire length of the canal. This keeps the canal free from vegetation, prevents the accumulation of silt, and eliminates the necessity of an annual clean-up.

South Field Irrigation Company's canal.—This canal is taken out of the river

on the south side, below the Salem canal. It irrigates what is known as the Spanish Fork south field. It was constructed in 1867, partly by labor of the appropriators and partly by contract. Measurements are made every week, by the water master, over a weir board. Measurement made in 1899 is given in the last table on this page.

City canal.—This canal heads on the north side of the river, and conducts the water northwesterly about 3 miles, to the city of Spanish Fork. The water is used for power and for irrigation purposes. After leaving the mills the water used for power purposes is again used for irrigation. The water is owned by three companies—Spanish Fork Municipal Corporation, Southeast Field Irrigation Company, and Spanish Fork West Field Irrigation Company. The canal was built in 1850, by day labor of the appropriators; in 1865 it was enlarged to its present size. To the division gates, where the water is divided into the three canals by weir gates, as they are called, it is controlled by the city of Spanish Fork.

Lake Shore canal.—This canal is the last one diverting water from Spanish Fork. It heads on the south side of the river, about 3 miles west of the city of Spanish Fork. The channel of the river at that point is cut deep into the sandy soil, and consequently the canal is very deep.

Data regarding Spanish Fork canals.

Name of canal.	Year of appropriation.	Capital stock.	Number of shares.	Value of shares.	Dimensions.		
					Length.	Width.	Depth.
					Miles.	*Feet.*	*Feet.*
East Bench canal							
Salem Irrigation Company's canal		$44,160	2,208	$20.00	6		
South Field Irrigation Company's canal	1867	39,600	3,300	12.00	7		
City canal					a 3		
Spanish Fork Municipal Corporation canal	1850						
Southeast Field Irrigation Company's canal	1865						
Spanish Fork West Field Irrigation Company's canal	1865						
Lake Shore canal							

a Length of main canal, exclusive of laterals.

Duty of water of Spanish Fork canals in 1899.

Name of canal.	Measurements.		Length of irrigation period.	Duty of water.		
	Date.	Discharge.		Area irrigated.	Amount used.		Depth.
	1899.	*Sec.-ft.*		*Acres.*	*Sec.-ft.*	*Acre-ft.*	*Feet.*
East Bench canal	May 11	80.47					
Do	Aug. 22	28.19	May 1 to Sept. 15	5,000	54.30	15,940	3.19
Salem Irrigation Company's canal	do	22.05	do	2,208	22.05	6,473	2.93
South Field Irrigation Company's canal	do	37.39	do	4,000	37.39	10,976	2.74
City canal	do	38.51	do	6,500	38.51	11,307	1.74

AMERICAN FORK.

Beginning at the north end, the first river entering Utah Valley is the American Fork. This stream is probably the third in importance. It rises in the northeastern part of Utah County, on the western slope

of the Wasatch Mountains, and flows in a southwesterly direction into Utah Lake. The water is used for power and for irrigation purposes. It is very cold and is perfectly transparent as it emerges from the deep canyon into the valley. The power plant is above the headworks of the canals, and all of the water reenters the river before any is diverted for irrigation purposes. All of the water in the river is diverted at the mouth of the canyon into three canals, namely, the Lehi canal, the American Fork canal, and the Pleasant Grove canal. A crib weir is placed across and at right angles to the river bed, being held in place by rock filling. The upper side of the weir is made impervious by planking and earth filling. Near the top of the weir are four rectangular openings, which allow the water to flow into the respective canals, two of the openings being for the American Fork canal. The admission of water is regulated by means of flashboards. The waters of the American Fork are divided as follows: Lehi canal, one-third from July 1 to September 20, one-sixth from September 20 to July 1; American Fork canal, eight twenty-firsts during the irrigation period; Pleasant Grove canal, two-sevenths from April 15 to September 20, and from September 20 to April 15 only sufficient for culinary purposes.

Lehi canal.—This canal is on the north side of the canyon, and has a westerly course to Lehi, a distance of 5 miles. A shortage of water occurs each year, due to an insufficient amount in the river.

American Fork canal.—This canal receives its water through the middle portion of the river weir. The direction of the canal is southwest, following the old river bed the greater part of the distance to the city of American Fork. The water is under the control of that city. The rights were acquired by appropriation. They belong to the land for which the water was appropriated and can not be transferred. There has always been a shortage of water, not more than half the necessary quantity being available, but there has been no litigation on that account, probably because the distribution is under municipal control.

Pleasant Grove canal.—This canal receives its water from the south opening in the American Fork weir. The direction of the canal is southeasterly to Pleasant Grove. It irrigates the city lots of Pleasant Grove and the fields in that vicinity.

Duty of water of American Fork canals in 1899.

Name of canal.	Measurements.		Length of irrigation period.	Duty of water.			
	Date.	Discharge.		Area irrigated.	Amount used.		Depth.
	1899.	*Sec.-ft.*		*Acres.*	*Sec.-ft.*	*Acre-ft.*	*Feet.*
Lehi canal	Aug. 25	17.82	Apr. 1 to Sept. 20				
American Fork canal	May 9	73.91	do	7,000			
Do	Aug. 25	28.85			51.38	17,631	2.52
Pleasant Grove canal	May 9	39.40					
Do	Aug. 25	10.71	Apr. 1 to Sept. 20	5,000	25.05	8,596	1.72

HOBBLE CREEK.

Hobble Creek enters Utah Valley at about the center of its eastern side, and irrigates the land in Springville and the immediate vicinity.

All of the canals diverting water from the creek are under the control of the city of Springville. A water privilege consists of the right to use a certain amount of water, apportioned by the water master, for three hours per acre each three weeks. These rights were acquired by appropriation, and can not be transferred from one party to another except by a transfer of the land. The chief water master is appointed by the city council for the term of one year. He in turn appoints sub water masters, who divide the water among the irrigators of their respective districts.

There is an annual tax of 6 cents per acre watered, to meet the expenses of the system. Usually there are six applications of the water to the land each year, some crops requiring more and some less than that number.

Nearly every year prior to 1899 there has been a shortage in the canals diverting water from Hobble Creek, but there has never been any litigation in consequence of the shortage. When the water becomes low in the latter part of the season the irrigators having the titles of most recent dates are deprived of the use of the water, all of which is reserved for those having prior rights.

Mapleton Reservoir canal.—This is the uppermost canal diverting water from Hobble Creek. It heads a short distance above the mouth of the canyon. It was constructed in 1878, by the appropriators. In the spring of 1899 it was bought by the city of Springville for $750, under an agreement which gave the former owners an equal right with the remainder of the Springville irrigators.

Mapleton Union canal.—This is the second canal diverting water from Hobble Creek. It takes its water from the south side of the stream. It was built in 1853 and went under the control of the city in 1877.

North Bench canal.—This is the third canal diverting water from the creek, and the uppermost on the north side. It was built in 1852. The seepage into it from the hillside was found to be 0.04 second-foot in a distance of three-fourths of a mile.

Island canal.—This is the fourth canal diverting water from the creek. It is taken out on the north side, and was constructed in 1851.

Sage Creek canal.—This is the fifth canal diverting water from the creek. It is on the south side of the stream. It was constructed in 1860, by the labor of the appropriators.

South Big Field ditch.—This canal diverts water from the north side of the creek. It was constructed in 1861.

City ditch.—This is the lowest ditch diverting water from Hobble Creek. It was constructed in 1850, by the labor of the owners.

Data regarding Hobble Creek canals.

Name of canal.	Year of appropriation.	Length of canal.
		Miles.
Mapleton Reservoir canal	1878	0.75
Mapleton Union canal	1868	3.0
North Bench canal	1852	3.0
Island canal	1851	1.0
Sage Creek canal	1860	1.5
South Big Field ditch	1851	2.0
City ditch	1850	1.0

Duty of water of Hobble Creek canals in 1899.

Name of canal.	Measurements.		Length of irrigation period.	Duty of water.			
	Date.	Discharge.		Area irrigated.	Amount used.		Depth.
	1899.	*Sec.-feet.*		*Acres.*	*Sec.-ft.*	*Acre-ft.*	*Feet.*
Mapleton Reservoir canal	May 10	7.87	May 1 to Sept. 15	100			
Do	Aug. 21	8.09					
Mapleton Union canal	May 10	26.14					
Do	Aug. 21	17.95 19.11	May 1 to Sept. 15	2,400	22.12	6,055	2.52
North Bench canal	May 10	11.65					
Do	Aug. 21	8.39	May 1 to Sept. 15	800	10.00	2,737	2.72
Island canal	do	4.02	do	250	4.02	1,101	4.40
Sage Creek canal	do	5.96	do	500	5.96	1,631	3.26
South Big Field ditch	do	5.52	do	800	5.52	1,511	1.89
City ditch	do	2.21	do	400	2.21	605	1.51

PETEETNETR CREEK.

Perhaps the best and most complete irrigation system in Utah Valley is that of Peteetnetr Creek. This stream has its source near the top of the high mountains north of Mount Nebo, about 10 miles southeast of Payson. At the head of the creek and its branches are five reservoirs. The largest covers 30 acres and has a mean depth of 10 feet; the next largest covers 25 acres and has a mean depth of 10 feet; the others cover from 7 to 10 acres each, with mean depths of from 5 to 7 feet. The dams are all of earth. The construction of the largest reservoir is under the charge of Mr. R. C. Gemmel, State engineer of Utah. The reservoirs were begun in 1887, but no benefits were derived from them until 1891. They are fed principally by the flood waters that occur during the spring, the springs flowing to them being small. The reservoirs and the creek are under the control of the city of Payson. There is an annual tax, for the maintenance of the system and the payment of the water master, of 25 cents per acre for farms and 65 cents per acre for city lots. The water of the creek and the reservoirs is divided into seventeen streams, through seventeen Cippoletti weirs, and the water of the streams is distributed on a time basis. The area irrigated is 1,400 acres. The flow of the creek is measured above all diversions over a rectangular weir with 12 feet length of crest.

Measurements over weir on Peteetnetr Creek in 1899.

Date.	Depth of water.	Discharge.	Discharge for month.	Depth for month.
1899.	*Feet.*	*Sec.-ft.*	*Acre-ft.*	*Feet.*
May 1	0.6667	21.3	4,396	3.14
May 15	2.1667	121.8		
June 1	1.4167	65.2		
June 15	.8333	29.7	2,826	2.02
July 1	.7083	23.3		
July 15	.6667	21.3	1,371	.98
August 1	.5729	17.0		
August 15	.5417	15.6	1,002	.71

NOTE.—The number of acre-feet and the depth are greater than those actually used, the measurements being made a great distance from the land to which the water was applied, and there being considerable loss by seepage and evaporation.

The water of the creek was appropriated in 1851. The water master, appointed by the city council, attends to the general division of the water at the weirs. When necessary he appoints sub water masters to attend to the subdivision. At the beginning of each irrigation season the water master issues to each irrigator a schedule stating the time at which he is to take the water for each turn during the entire season. There has not been a shortage of water on this stream since 1888, and there has been no litigation on account of shortage.

The principal crops raised are wheat, oats, potatoes, fruit, and sugar beets. Of the last, 160 acres were raised in 1898, the average yield being 18 tons per acre. This would make a total of 2,880 tons, the value of which, at $3.75 per ton, would be $10,800, or $67.50 per acre.

CURRENT CREEK.

This creek heads near the western base of Mount Nebo. Its general course is north. It is about 12 miles long, and empties into Utah Lake at the extreme southern end.

Its waters are impounded by a dam placed across the channel about 1 mile west of Goshen. This reservoir is used as a distribution basin, from which seven canals receive their supply of water. The creek irrigates about 2,500 acres. The irrigation period extends from April 1 to October 1.

On the west side of Mount Nebo, in the south end of Utah County, in what is known as Mona Valley, is the Mount Nebo Land and Irrigation Company's reservoir, which when full covers about 2,000 acres to a mean depth of 12 feet, and is supplied by the winter flow of Current Creek. The dam is built of selected and graded earth. The top length is 215 feet, the bottom length 125 feet. The bottom width is 101 feet, the top width 10 feet, the height 25 feet. About 25 feet down the lower slope there is a 3-foot berm. The entire dam is covered with riprap. The outlet tunnel is cut through the solid rock, about 37 feet below the surface. The valves are of the kind known as the butterfly valve—fastened to vertical shafts and operated from the valve house by a worm gear. The spillway is cut through the solid rock around the northern end of the dam. It is 25 feet wide, 5 feet deep, 200 feet long, and its crest is 5 feet below the top of the dam. The water is drawn off and emptied into the old creek bed below the dam, and is carried down the canyon about 2 miles to the division gates, where the reservoir water is diverted into the canal of the Mount Nebo Irrigation Company, and the natural flow of the stream is allowed to pass down the old channel. The water of the Mount Nebo Irrigation Company is conducted by a semicircular stave flume the greater part of the distance down the canyon. One crossing of the canyon is made on a trestle and another by means of an inverted siphon. At each end of the siphon the flume is gradually

contracted into the pipe. In 1899 the water from this reservoir irrigated about 2,100 acres, but there was only about five-sixths of the quantity necessary to mature the crops. There are about 10,000 acres of land tributary to the canal.

SUMMIT CREEK.

Summit Creek rises in the tops of the mountains on the south-central side of Utah Valley. Its course is northwest, and its length about 8 miles. The first and only measurement of the stream made by the writer was on August 23, 1899. The discharge at that time was 14.64 second-feet. The stream is owned and controlled by the Santaquin Irrigation and Canal Company, which was incorporated in 1875. The irrigation season is from April 1 to October 25.

GOSHEN WARMSPRINGS CREEK.

This creek rises in the level of Goshen Valley—adjacent to Utah Valley at the extreme southern end—near the base of the Nebo Range, and irrigates land on the east side of Goshen Valley. On August 23, 1899, the aggregate discharge of the streams, three in number, was estimated to be 5.5 second-feet, which was an average of the flow for the season. The number of acres irrigated is 825. The irrigation season extends from April 1 to October 1, or 183 days. The total discharge during that time would be 2,006 acre-feet, which would cover the 825 acres to a depth of 2.42 feet. The crops raised are meadow hay, alfalfa, and grain.

ROCK CANYON CREEK.

This stream flows from a deep canyon northeast of the city of Provo, and irrigates land lying between the foot of the mountains and the Timpanogas canal. The irrigation season extends from April 1 to September 1. The mean discharge during the irrigation season is nearly 4 second-feet, or a total of 1,214 acre-feet. The area irrigated is 400 acres, which would be covered to a depth of 3.04 feet. The soil consists of a gravel and sand wash. The crops raised are grain and alfalfa.

SPRING LAKE CREEK.

This creek has its source in a small lake or pond which covers 20 acres to a mean depth of 4 feet. It is used as a storage reservoir and also as a means of raising the water sufficiently to irrigate the higher land. A measurement of the stream was made on August 23, 1899, the discharge being 2.89 second-feet. The number of acres irrigated is 150.

RATING TABLES.

The following pages contain the rating tables for the various river stations described in Water-Supply Papers Nos. 47 to 51, inclusive. In each case the table shows the relation which has been found to exist during the year 1900 between the height of water on the gage and the discharge in cubic feet per second. The tables have been prepared from measurements made during 1900 or previous years, and are used in computing the daily flow, the results of which will be published in the Twenty-second Annual Report, Part IV.

Referring to the tables, the numbers in parentheses in the box heads are the pages in the Water-Supply Papers of the series for 1900 (Nos. 47 to 51, inclusive) on which the various gaging stations are described. At the end of the descriptions are given the results of discharge measurements made during 1900 and the daily gage heights. From these and earlier data the relation of gage height to discharge has been deduced. Take, for example, the first table—Delaware River at Lambertville, New Jersey. On page 80 of Water-Supply Paper No. 47 is given the daily gage height, in feet, at that station during the year 1900. On March 1 the gage height was 5.40 feet. The flow equivalent to that gage height is shown in the following table to be 20,300 second-feet. With the gage heights and the rating tables at hand, the daily and monthly flow of any stream can easily be determined. The latter (the monthly discharge) has been worked up for most of the stations maintained by the Survey, and will, as already stated, be published in the Twenty-second Annual Report, Part IV.

Rating tables for stations in New Jersey, Pennsylvania, Maryland, and West Virginia.

[Numbers in box heads refer to pages in Water-Supply Papers Nos. 47 and 48.]

Gage height, in feet.	Discharge, in second-feet.											
	Delaware River at Lambertville, N. J. (80).	North Branch of Susquehanna River at Wilkesbarre, Pa. (110).	North Branch of Susquehanna River at Danville, Pa. (111).	West Branch of Susquehanna River at Allenwood, Pa. (111).	Juniata River at Newport, Pa. (112).	Susquehanna River at Harrisburg, Pa. (113).	Patapsco River at Woodstock, Md. (115).	North Branch of Potomac River at Piedmont, W. Va. (115).	Antietam Creek near Sharpsburg, Md. (117).	North Branch of Shenandoah River near Riverton, Va. (118).	Shenandoah River at Millville, W. Va. (120).	Potomac River at Point of Rocks, Md. (121).
0.0						2,500						
.2						3,230						1,000
.4						4,020					540	1,400
.6						4,820					740	1,860
.8						5,720					940	2,360
1.0						6,880					1,140	2,900
1.2				300		8,150			38		1,370	3,600
1.4				500		9,450			60		1,650	4,300
1.6			825	750		10,750			95		1,950	5,100
1.8			1,100	1,050		12,300		34	154		2,260	6,020
2.0			1,400	1,350		13,900		77	217		2,600	7,000
2.2		1,000	1,800	1,700		15,500		124	281		2,960	7,980
2.4	1,750	1,200	2,250	2,150		17,300		175	348		3,340	8,960
2.6	2,100	1,400	2,750	2,650	350	19,300		230	416	140	3,740	9,940
2.8	2,600	1,600	3,300	3,250	600	21,300		289	485	240	4,160	10,920
3.0	3,300	1,860	3,900	4,000	1,000	23,400	50	352	560	380	4,600	11,900
3.2	4,100	2,120	4,550	5,200	1,400	25,625	83	430	665	580	5,060	13,040
3.4	5,050	2,400	5,250	7,500	1,820	27,925	122	525	775	805	5,540	14,240
3.6	6,100	2,700	6,000	10,750	2,270	30,300	173	640	887	1,035	6,050	15,460
3.8	7,250	3,000	6,800	14,000	2,750	32,800	235	775	1,001	1,265	6,600	16,680
4.0	8,550	3,300	7,650	17,250	3,250	35,400	310	920	1,215	1,495	7,190	17,900
4.2	10,000	3,600	8,575	20,500	3,750	38,100	400	1,080	1,329	1,725	7,790	19,120
4.4	11,650	3,940	9,525	23,750	4,300	41,100	520	1,240	1,443	1,955	8,410	20,340
4.6	13,350	4,340	10,500	27,000	4,900	44,590	670	1,400	1,557	2,185	9,040	21,560
4.8	15,050	4,760	11,500	30,250	5,500	48,170	830	1,560	1,671	2,415	9,680	22,780
5.0	16,750	5,200	12,550	33,500	6,200	51,750	1,000	1,720	1,785	2,645	10,320	24,000
5.2	18,500	5,700	13,720	36,750	6,900	55,330	1,200	1,880		2,875	10,960	25,220
5.4	20,300	6,250	14,900	40,000	7,700	58,910	1,400	2,040		3,105	11,600	26,440
5.6	22,150	6,850	16,100	43,250	8,500	62,490	1,600	2,200		3,335	12,240	27,660
5.8	24,050	7,560	17,390	46,500	9,350	66,070	1,800	2,360		3,565	12,880	28,880
6.0	25,950	8,340	18,800	49,750	10,250	69,650	2,000	2,520		3,795	13,520	30,100
6.2	27,850	9,240	20,240	53,000	11,150	73,230	2,205	2,680		4,025	14,160	31,400
6.4	29,750	10,260	21,680	56,250	12,060	76,810	2,410	2,840		4,255	14,800	32,700
6.6	31,700	11,360	23,120	59,500	13,000	80,390	2,615	3,000		4,485	15,440	34,100
6.8	33,710	12,480	24,560	62,750	14,000	83,970	2,820	3,160		4,715	16,080	35,500
7.0	35,750	13,600	26,000	66,000	15,000	87,550	3,025	3,320		4,945	16,720	36,950
7.5	40,900	16,400	29,660	74,125	17,500	96,500	3,538	3,720		5,520		40,800
8.0	46,050	19,200	33,200	82,250	20,000	105,450	4,050	4,120				44,900
8.5	51,200	22,000	36,800	90,375	22,500	114,400	4,562	4,520				49,300
9.0	56,350	24,800	40,400	98,500	25,000	123,350		4,920				53,850
9.5	61,500	27,600	44,000	106,625	27,500	132,300						58,400
10.0		30,400	47,600	114,750	30,000	141,250						62,950
10.5		33,200	51,200	122,875	32,500	150,200						67,500
11.0		36,000	54,800	131,000	35,000	159,150						72,050
11.5		38,800	58,400	139,125		168,100						76,600
12.0		41,600	62,000	147,250		177,050						81,150
12.5		44,400		155,375		186,000						85,700
13.0		47,200		163,500		194,950						90,250
13.5		50,000				203,900						94,800
14.0		52,800				212,850						99,350
14.5		55,600				221,800						103,900
15.0		58,400				230,750						108,450
15.5		61,200				239,700						113,000
16.0		64,000				248,650						117,550
16.5		66,800				257,600						122,100
17.0		69,600				266,550						126,650

Rating tables for stations in Maryland, Virginia, North Carolina, and South Carolina.

[Numbers in box heads refer to pages in Water-Supply Paper No. 48.]

Gage height, in feet.	Discharge, in second-feet.											
	Monocacy River near Frederick, Md. (125).	North (of James) River at Glasgow, Va. (127).	James River at Buchanan, Va. (128).	James River at Cartersville, Va. (128).	Roanoke River at Roanoke, Va. (130).	Roanoke River at Neal, N. C. (131).	Tar River at Tarboro, N. C. (134).	Neuse River at Selma, N. C. (135).	Cape Fear River at Fayetteville, N. C. (137).	Yadkin River at Salisbury, N. C. (139).	Catawba River at Rock-hill, S. C. (144).	Broad River (of the Carolinas) near Alston, S. C. (146).
0.2	.....	.....	.....	.....	.....	1,440	a 290	b 150	.....	.....	.....	.....
.4	.....	.....	.....	720	55	1,560	350	184	330	.....	.....	.....
.6	.....	.....	.....	910	85	1,680	410	218	375	.....	.....	.....
.8	.....	280	.....	1,150	120	1,800	480	252	429	.....	.....	.....
1.0	.....	350	.....	1,420	170	1,920	550	290	489	.....	.....	.....
1.2	.....	450	.....	1,730	240	2,050	620	330	550	1,040	.....	.....
1.4	.....	580	.....	2,060	325	2,180	690	370	612	1,300	1,550	.....
1.6	.....	720	310	2,420	420	2,310	760	413	678	1,560	1,750	.....
1.8	.....	890	360	2,800	540	2,440	840	459	744	1,870	2,030	1,210
2.0	.....	1,090	430	3,200	670	2,580	920	505	810	2,250	2,390	1,470
2.2	.....	1,300	540	3,600	820	2,720	1,000	555	876	2,750	2,830	1,735
2.4	.....	1,520	670	4,000	1,010	2,860	1,080	605	946	3,250	3,380	2,010
2.6	.....	1,750	840	4,410	1,240	3,000	1,160	658	1,022	3,790	4,060	2,300
2.8	.....	1,990	1,050	4,830	1,540	3,140	1,240	714	1,108	4,370	4,880	2,720
3.0	.....	2,240	1,330	5,260	1,920	3,280	1,320	770	1,187	4,950	5,750	3,160
3.2	.....	2,500	1,650	5,700	2,325	3,420	1,400	830	1,273	5,610	6,632	3,620
3.4	.....	2,760	1,980	6,140	2,735	3,560	1,480	890	1,367	6,285	7,516	4,080
3.6	45	3,020	2,330	6,580	3,145	3,700	1,565	951	1,467	6,990	8,400	4,540
3.8	90	3,300	2,690	7,040	3,555	3,840	1,655	1,013	1,567	7,720	9,284	5,000
4.0	150	3,590	3,050	7,520	3,965	3,980	1,745	1,075	1,674	8,450	10,168	5,460
4.2	210	3,890	3,440	8,010	4,375	4,120	1,845	1,141	1,782	9,270	11,052	5,920
4.4	270	4,190	3,840	8,520	4,785	4,260	1,945	1,207	1,890	10,100	11,936	6,410
4.6	340	4,490	4,240	9,040	5,195	4,400	2,045	1,274	1,994	10,960	12,820	6,910
4.8	420	4,810	4,640	9,560	5,605	4,540	2,155	1,342	2,102	11,880	13,704	7,410
5.0	500	5,130	5,060	10,060	6,015	4,680	2,265	1,410	2,210	12,800	14,588	7,910
5.5	750	6,010	6,060	11,380	7,040	5,055	2,565	1,590	2,470	15,250	16,798	9,200
6.0	1,020	6,910	7,210	12,680	8,065	5,430	2,865	1,780	2,740	18,000	19,008	11,000
6.5	1,450	7,870	8,410	14,030	9,090	5,830	3,205	1,980	3,010	21,000	21,218	13,135
7.0	1,880	8,900	9,660	15,380	10,115	6,230	3,580	2,190	3,280	24,060	23,428	15,270
7.5	2,310	9,970	10,910	16,730	11,140	6,705	3,955	2,415	3,550	27,130	25,638	17,420
8.0	2,740	11,070	12,190	18,080	12,165	7,200	4,330	2,645	3,822	30,425	27,848	19,570
8.5	3,170	.....	13,490	.....	.....	7,700	4,745	2,895	4,102	33,750	30,058	21,745
9.0	3,600	.....	14,790	.....	.....	8,200	5,160	3,160	4,382	37,125	32,268	23,920
9.5	4,030	.....	16,090	.....	.....	8,730	5,575	3,435	4,672	40,500	34,478	26,095
10.0	4,460	.....	17,420	.....	.....	9,280	5,990	3,710	4,955	43,950	36,688	28,270
10.5	4,890	.....	18,770	.....	.....	9,830	6,405	4,000	5,245	47,560	38,898	30,520
11.0	5,320	.....	20,120	.....	.....	10,380	6,820	4,305	5,535	51,250	41,108	32,770
11.5	5,750	.....	21,520	.....	.....	10,955	7,235	4,630	5,833	55,000	43,318	35,020
12.0	6,180	.....	22,920	.....	.....	11,530	7,650	4,965	6,133	58,750	45,528	37,270
12.5	6,610	.....	24,320	.....	.....	12,105	8,070	5,325	6,433	62,625	.....	39,520
13.0	7,040	.....	25,720	.....	.....	12,680	8,490	5,700	6,733	66,525	.....	41,770
13.5	7,470	.....	27,120	.....	.....	13,255	8,925	6,075	7,033	70,425	.....	44,020
14.0	7,900	.....	28,530	.....	.....	13,830	9,370	6,465	7,333	74,325	.....	46,270
14.5	8,330	.....	29,930	.....	.....	14,405	9,820	6,855	7,633	78,375	.....	48,520
15.0	8,760	.....	31,330	.....	.....	15,000	10,270	7,250	7,933	82,500	.....	50,770
16.0	9,620	.....	34,130	.....	.....	16,200	11,170	8,050	8,541	91,000	.....	55,270
17.0	10,480	.....	.....	.....	.....	17,430	12,070	8,880	9,161	99,600	.....	59,770
18.0	11,340	.....	.....	.....	.....	18,680	12,970	9,710	9,781	108,200	.....	64,270
19.0	.....	.....	.....	.....	.....	20,080	13,870	10,540	10,401	116,800	.....	68,770
20.0	.....	.....	.....	.....	.....	22,000	14,850	11,370	11,569	.....	.....	73,270
25.0	.....	.....	.....	.....	.....	40,400	.....	.....	18,364	.....	.....	.....
30.0	.....	.....	.....	.....	.....	.....	.....	.....	25,159	.....	.....	.....
35.0	.....	.....	.....	.....	.....	.....	.....	.....	33,600	.....	.....	.....
40.0	.....	.....	.....	.....	.....	.....	.....	.....	44,000	.....	.....	.....
45.0	.....	.....	.....	.....	.....	.....	.....	.....	54,500	.....	.....	.....
50.0	.....	.....	.....	.....	.....	.....	.....	.....	65,000	.....	.....	.....

a Continued: Gage height —0.2, discharge 134; gage height 0.0, discharge 230.
b Continued: Gage height —0.2, discharge 113; gage height 0.0, discharge 120.

Rating tables for stations in South Carolina and Georgia.

[Numbers in box heads refer to pages in Water-Supply Paper No. 48.]

Gage height, in feet.	Discharge, in second-feet.											
	Saluda River at Waterloo, S. C. (147).	Tallulah River at Tallulah Falls, Ga. (148).	Tugaloo River near Madison, S. C. (149).	Savannah River near Calhoun Falls, S.C. (149).	Savannah River at Augusta, Ga. (150).	Broad River (of Georgia) near Carlton, Ga. (151).	Oconee River near Dublin, Ga. (152).	Yellow River at Almon, Ga. (153).	Towaliga River near Juliette, Ga. (154).	Ocmulgee River at Macon, Ga. (155).	Flint River at Woodbury, Ga. (157).	Chattahoochee River at Oakdale, Ga. (158).
−0.8							a 1,015					
−.6							1,095					
−.4							1,185					
−.2							1,300					
.0							1,425				350	
.2							1,552				400	910
.4							1,681				460	1,000
.6		160					1,812				530	1,100
.8		200					1,945				650	1,220
1.0		252					2,080		120		800	1,350
1.2		313	705				2,218		135	940	1,000	1,490
1.4		385	775				2,358	200	154	1,040	1,245	1,630
1.6		470	845			380	2,500	230	177	1,140	1,500	1,780
1.8		580	920			450	2,644	260	204	1,250	1,780	1,940
2.0	300	700	1,000	1,760		540	2,790	290	237	1,360	2,080	2,100
2.2	320	840	1,090	1,990		660	2,938	330	273	1,480	2,340	2,270
2.4	340	980	1,180	2,280		800	3,089	370	309	1,600	2,620	2,450
2.6	360	1,120	1,275	2,690		940	3,243	410	345	1,720	2,900	2,630
2.8	380	1,260	1,375	3,150		1,080	3,400	455	381	1,840	3,180	2,810
3.0	405	1,400	1,475	3,900		1,220	3,560	505	417	1,960	3,460	3,000
3.2	450	1,540	1,580	4,770		1,370	3,720	555	453	2,080	3,740	3,200
3.4	510	1,680	1,690	5,640		1,520	3,890	605	489	2,200	4,020	3,405
3.6	600	1,820	1,800	6,510		1,680	4,070	660	525	2,320	4,300	3,615
3.8	720	1,960	1,920	7,380		1,840	4,260	720	561	2,440	4,580	3,825
4.0	850	2,100	2,060	8,250	2,350	2,000	4,460	780	597	2,560	4,860	4,035
4.2	980		2,220	9,120	2,470	2,180	4,672	850	633	2,680	5,140	4,250
4.4	1,110		2,380	9,990	2,695	2,360	4,888	920	669	2,800	5,420	4,470
4.6	1,240		2,540	10,860	2,725	2,550	5,108	990	705	2,920	5,700	4,700
4.8	1,375		2,700	11,735	2,860	2,750	5,332	1,080	741	3,040	5,980	4,930
5.0	1,515		2,860	12,600	3,000	2,950	5,560	1,175	777	3,160	6,260	5,160
5.2	1,660		3,020	13,470	3,160	3,160	5,788	1,275	813	3,280	6,540	5,420
5.4	1,820		3,180	14,340	3,340	3,390	6,016	1,375	849	3,400	6,820	5,700
5.6	1,980		3,340	15,210	3,540	3,640	6,244	1,480	885	3,520	7,100	6,000
5.8	2,140		3,500	16,080	3,760	3,900	6,472	1,585	921	3,640	7,380	6,300
6.0	2,300		3,660	16,950	4,000	4,160	6,700	1,690	957	3,760	7,660	6,600
6.5	2,700		4,060	19,125	4,620	4,825	7,270	1,958	1,047	4,060	8,360	7,350
7.0	3,100		4,460	21,300	5,300	5,500	7,840	2,227	1,137	4,360	9,060	8,100
7.5	3,500		4,860	23,475	6,050	6,175	8,410	2,495	1,227	4,660	9,760	8,850
8.0	3,900		5,260	25,650	6,800	6,850	8,980	2,763	1,317	5,010	10,460	9,600
8.5	4,300		5,660	27,825	7,600	7,525	9,550	3,031	1,407	5,410	11,160	10,350
9.0	4,700		6,060	30,000	8,400	8,200	10,120	3,300	1,497	5,810	11,860	11,100
9.5	5,100		6,460	32,175	9,250	8,875	10,690	3,568	1,587	6,250		11,850
10.0	5,500		6,860	34,350	10,100	9,550	11,260	3,837	1,677	6,820		12,600
11.0	6,300		7,660	38,700	11,900	10,900	12,400	4,375	1,857	8,020		14,100
12.0	7,100		8,460	43,050	13,800	12,250	13,540	4,912	2,037	9,400		15,600
13.0	8,100		9,260	47,400	15,800	13,600	14,680	5,450	2,217	11,240		17,100
14.0	9,100		10,060	51,750	17,900	14,950	15,820	5,987	2,397	13,900		18,600
15.0	10,100		10,860	56,100	20,100	16,300	16,960	6,525	2,577	18,100		20,100
16.0	11,100		11,660		22,400	17,650	18,100		2,757	22,300		21,600
18.0	13,100				27,300		20,380			30,700		24,600
20.0	15,100				33,300		22,660					
22.0					41,000		24,940					
24.0					52,000		27,220					
26.0					68,800							
28.0					86,400							
30.0					104,000							

a Continued: Gage height −1.2, discharge 890; gage height −1.0, discharge 950.

Rating tables for stations in Georgia, Alabama, Maryland, and Virginia.

[Numbers in box heads refer to pages in Water-Supply Paper No. 48.]

Gage height, in feet.	Discharge, in second-feet.											
	Chattahoochee River at West Point, Ga. (159).	Etowah River at Canton, Ga. (160).	Coosawattee River at Carters, Ga. (161).	Oostanaula River at Resaca, Ga. (162).	Coosa River at Rome, Ga. (163).	Coosa River near Riverside, Ala. (164).	Tallapoosa River near Susanna, Ala. (166).	Tallapoosa River near Milstead, Ala. (168).	Black Warrior River at Tuscaloosa, Ala. (170).	Big Sandy Creek near Dadeville, Ala. (174).	Youghiogheny River at Friendsville, Md. (176).	New River at Radford, Va. (178).
−0.4		275										
−.2		385										
.0		515							280			1,400
.2		665							340			1,800
.4		820							400			2,220
.6		988							460			2,700
.8		1,154			1,930				530			3,250
1.0	935	1,320		460	2,110	2,460			600	110		3,880
1.2	1,000	1,486	425	500	2,350	2,760			670	200		4,765
1.4	1,180	1,652	495	550	2,600	3,100	1,680		750	315		5,715
1.6	1,380	1,818	575	600	2,850	3,500	1,960	1,450	830	465		6,665
1.8	1,600	1,984	670	650	3,120	3,940	2,320	1,675	910	655		7,615
2.0	1,840	2,150	765	705	3,400	4,400	2,740	1,900	1,000	870		8,565
2.2	2,100	2,316	865	770	3,700	4,900	3,230	2,125	1,090	1,110		9,515
2.4	2,380	2,482	970	840	4,000	5,430	3,850	2,350	1,180	1,350		10,660
2.6	2,680	2,648	1,075	920	4,300	5,970	4,730	2,575	1,270	1,590		11,980
2.8	3,000	2,814	1,180	1,000	4,600	6,530	5,630	2,800	1,370	1,830		13,325
3.0	3,340	2,980	1,290	1,100	4,900	7,100	6,530	3,025	1,470	2,070		14,680
3.2	3,700	3,146	1,400	1,220	5,230	7,700	7,430	3,250	1,570	2,310		16,050
3.4	4,080	3,312	1,510	1,340	5,580	8,330	8,330	3,475	1,670	2,550		17,440
3.6	4,480	3,478	1,625	1,460	5,930	8,970	9,230	3,700	1,780	2,790	20	18,830
3.8	4,920	3,644	1,750	1,580	6,300	9,620	10,130	3,925	1,890	3,030	65	20,380
4.0	5,370	3,810	1,875	1,700	6,700	10,300	11,030	4,150	2,000	3,270	130	21,890
4.2	5,880	3,976	2,010	1,820	7,102	11,000	11,930	4,375	2,111	3,510	210	
4.4	6,400	4,142	2,145	1,940	7,504	11,700	12,830	4,600	2,222	3,750	300	
4.6	6,940	4,308	2,280	2,080	7,906	12,400	13,730	4,825	2,333		400	
4.8	7,490	4,474	2,415	2,220	8,308	13,100	14,630	5,050	2,444		515	
5.0	8,040	4,640	2,550	2,360	8,710	13,800	15,530	5,275	2,555		640	
5.5	9,420	5,055	2,910	2,780	9,715	15,550	17,780	5,837	2,832		1,050	
6.0	10,800	5,470	3,270	3,230	10,720	17,300	20,030	6,400	3,110		1,600	
6.5	12,180	5,885	3,630	3,690	11,725	19,200	22,280	6,962	3,370		2,170	
7.0	13,560	6,300	3,990	4,150	12,730	21,100	24,530	7,525	3,665		2,740	
7.5	14,950	6,715	4,350	4,610	13,735	23,100		8,087	3,925		3,310	
8.0	16,400	7,130	4,710	5,070	14,740	25,100		8,650	4,220		3,880	
8.5	17,850	7,545	5,070	5,530	15,745	27,100		9,212	4,480		4,450	
9.0	19,300	7,960	5,430	5,990	16,750	29,100		9,775	4,775		5,020	
9.5	20,750	8,375	5,790	6,450	17,755	31,100		10,337	5,035		5,590	
10.0	22,200	8,790	6,150	6,910	18,760	33,100		10,900	5,330			
11.0	25,100	9,620		7,830	20,770	37,100		12,025	5,885			
12.0	28,800	10,450		8,750	22,780	41,100		13,150	6,440			
13.0	33,410	11,280		9,670	24,790	45,100		14,275	6,995			
14.0	38,030	12,110		10,590	26,800	49,100		15,400	7,550			
15.0	42,630	12,940		11,510	28,810	53,100		16,525	8,105			
16.0		13,770		12,430	30,820	57,100		17,650	8,660			
17.0		14,600		13,350	32,830	61,100		18,775	9,215			
18.0		15,430		14,270		65,100		19,900	9,770			
19.0				15,190		69,100		21,025	10,325			
20.0				16,110				22,150	10,380			
25.0								27,775	16,000			
30.0								33,400	24,600			
35.0								39,025	35,000			
40.0								44,650	49,000			
45.0									65,250			
50.0									84,000			
55.0									102,750			
60.0									121,500			

Rating tables for stations in West Virginia, North Carolina, Tennessee, Georgia, and Ohio.

[Numbers in box heads refer to pages in Water-Supply Papers Nos. 48 and 49.]

Gage height, in feet.	Discharge, in second-feet.											
	Greenbrier River at Alderson, W. Va. (178).	New River at Fayette, W. Va. (181).	French Broad River near Asheville, N. C. (186).	Tuckasegee River at Bryson, N. C. (188).	Little Tennessee River at Judson, N. C. (189).	Hiwassee River at Murphy, N. C. (190).	Hiwassee River at Reliance, Tenn. (191).	Hiwassee River at Charleston, Tenn. (192).	Toccoa River near Blueridge, Ga. (193).	Tennessee River at Chattanooga, Tenn. (195).	Olentangy River at Columbus, Ohio (218).	Scioto River at Columbus, Ohio (219).
0.0	.....	1,840	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.2	.....	1,960	.....	.....	.....	.....	.....	1,200	.....	.....	.....	.....
.4	.....	2,080	.....	.....	.....	.....	.....	1,380	.....	.....	.....	.....
.6	.....	2,240	.....	.....	.....	.....	.....	1,580	.....	.....	.....	.....
.8	.....	2,400	.....	.....	.....	.....	.....	1,820	.....	6,600	.....	.....
1.0	.....	2,560	.....	300	.....	.....	1,030	2,100	.....	7,300	8	.....
1.2	60	2,750	.....	500	.....	.....	1,180	2,400	.....	8,040	55	.....
1.4	120	2,950	.....	700	.....	.....	1,415	2,710	.....	8,820	145	.....
1.6	220	3,160	.....	950	.....	.....	1,750	3,040	.....	9,620	247	.....
1.8	350	3,380	.....	1,200	.....	.....	2,100	3,370	.....	10,430	365	.....
2.0	505	3,610	800	1,510	.....	.....	2,450	3,700	255	11,250	494	.....
2.2	685	3,850	890	1,850	325	.....	2,800	4,030	318	12,080	635	.....
2.4	920	4,100	1,020	2,190	427	.....	3,150	4,360	387	12,930	795	.....
2.6	1,205	4,380	1,190	2,540	596	.....	3,500	4,690	460	13,800	978	.....
2.8	1,535	4,690	1,380	2,900	828	.....	3,850	5,020	550	14,680	1,185	.....
3.0	1,900	5,030	1,610	3,260	1,060	.....	4,200	5,350	675	15,600	1,415	.....
3.2	2,330	5,290	1,880	3,650	1,310	.....	4,550	5,680	837	16,550	1,535	.....
3.4	2,770	5,650	2,190	4,075	1,595	.....	4,900	6,010	1,035	17,550	1,850	.....
3.6	3,240	6,010	2,530	4,550	1,935	.....	5,250	6,340	1,235	18,550	2,090	.....
3.8	3,720	6,370	2,900	5,125	2,315	.....	5,600	6,670	1,435	19,600	2,330	.....
4.0	4,200	6,730	3,290	5,750	2,695	.....	5,950	7,000	1,635	20,800	2,580	.....
4.2	4,680	7,090	3,710	6,400	3,075	.....	6,300	7,330	1,835	22,040	2,850	.....
4.4	5,160	7,460	4,210	7,050	3,455	.....	6,650	7,660	2,035	23,280	3,135	.....
4.6	5,660	7,860	4,760	7,700	3,850	240	.....	7,990	.....	24,520	3,445	.....
4.8	6,180	8,260	5,350	8,350	4,250	310	.....	8,320	.....	25,760	3,789	.....
5.0	6,700	8,660	6,000	9,000	4,650	415	.....	8,650	.....	27,000	4,135	.....
5.5	8,000	9,730	7,750	10,950	5,650	745	.....	9,475	.....	30,100	5,015	.....
6.0	9,500	10,880	9,500	13,450	6,720	1,325	.....	10,300	.....	33,200	5,905	.....
6.5	11,000	12,030	11,250	16,300	7,845	2,200	.....	11,125	.....	36,300	6,795	.....
7.0	12,500	13,250	13,000	19,175	9,030	3,075	.....	11,950	.....	39,400	7,685	.....
7.5	14,000	14,530	14,750	22,050	10,420	3,950	.....	12,775	.....	42,500	.....	.....
8.0	15,600	15,830	16,500	24,925	12,200	4,825	.....	13,600	.....	45,600	.....	.....
8.5	17,300	17,130	18,250	27,800	14,200	5,700	.....	14,425	.....	48,700	.....	.....
9.0	19,000	18,480	20,000	30,675	16,200	6,600	.....	15,250	.....	51,800	.....	9
9.5	20,700	19,870	.....	33,550	18,450	7,500	.....	16,075	.....	54,900	.....	91
10.0	22,500	21,310	.....	36,425	20,700	8,400	.....	16,900	.....	58,000	.....	275
11.0	26,500	24,480	.....	42,300	27,400	10,200	.....	18,550	.....	64,200	.....	778
12.0	31,200	27,900	.....	.....	37,400	12,000	.....	20,200	.....	70,400	.....	1,440
13.0	36,200	31,500	.....	.....	48,000	13,800	.....	.....	.....	76,600	.....	2,240
14.0	41,200	35,160	.....	.....	.....	15,600	.....	.....	.....	82,800	.....	3,300
15.0	46,200	38,960	.....	.....	.....	17,400	.....	.....	.....	89,000	.....	4,580
16.0	.....	.....	.....	.....	.....	19,200	.....	.....	.....	95,200	.....	6,130
17.0	.....	.....	.....	.....	.....	21,000	.....	.....	.....	101,400	.....	8,000
18.0	.....	.....	.....	.....	.....	22,800	.....	.....	.....	107,600	.....	.....
19.0	.....	.....	.....	.....	.....	24,600	.....	.....	.....	113,800	.....	.....
20.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	120,000	.....	.....
22.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	132,400	.....	.....
24.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	144,800	.....	.....
26.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	157,200	.....	.....
28.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	169,600	.....	.....
30.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	182,000	.....	.....
32.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	194,400	.....	.....
34.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	206,800	.....	.....
36.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	219,200	.....	.....
38.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	231,600	.....	.....
40.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	244,000	.....	.....

Rating tables for stations in Montana and Wyoming.

[Numbers in box heads refer to pages in Water-Supply Paper No. 49.]

Gage height, in feet.	Discharge, in second-feet.											
	West Gallatin River near Salesville, Mont. (260).	Middle Creek near Bozeman, Mont. (261).	Gallatin River at Logan, Mont. (262).	Madison River near Redbluff, Mont. (263).	Jefferson River at Sappington, Mont. (264).	Missouri River at Townsend, Mont. (265).	Milk River at Havre, Mont. (267).	Yellowstone River near Livingston, Mont. (268).	Bighorn River near Thermopolis, Wyo. (269).	Grand Encampment Creek at Peryam's ranch, Wyo. (273).	Laramie River at Woods, Wyo. (273).	North Platte River near Guernsey, Wyo. (275).
0.0		48				a 1,620		b 2,150	c 210			d 1,060
.2		88				1,825		2,375	400	10		1,340
.4		153	240			2,090		2,605	620	80	45	1,620
.6		232	345			2,415		2,855	940	195	60	1,920
.8		321	460			2,810		3,130	1,340	395	85	2,220
1.0		417	605	860		3,256		3,420	1,770	630	125	2,520
1.2			765	1,230	305	3,825		3,730	2,210	885	200	2,820
1.4			940	1,640	435	4,450	12	4,075	2,650	1,160	290	3,120
1.6			1,180	2,075	600	5,140	30	4,440	3,090	1,470	410	3,430
1.8			1,345	2,530	775	5,880	50	4,830	3,530	1,820	550	3,770
2.0			1,575	3,005	980	6,650	76	5,275	3,970	2,185	720	4,150
2.2			1,800	3,515	1,205	7,440	109	5,740	4,410	2,585	960	4,570
2.4			2,075	4,040	1,455	8,265	149	6,220	4,850	3,005	1,240	5,030
2.6			2,350	4,570	1,725	9,140	189	6,730	5,290	3,425	1,530	5,485
2.8	330		2,665	5,110	2,020	10,010	248	7,270	5,730	3,845	1,820	5,955
3.0	440		2,995	5,655	2,325	10,955	315	7,840	6,170	4,265	2,110	6,430
3.2	560		3,335	6,220	2,645	11,825	396	8,470	6,610	4,685	2,400	6,910
3.4	700		3,685	6,810	2,980	12,730	485	9,140	7,050		2,690	7,390
3.6	850		4,055		3,330	13,690	587	9,860	7,490		2,980	7,870
3.8	1,020		4,425		3,690	14,600	700	10,660	7,930		3,270	8,350
4.0	1,200		4,805		4,050	15,525	820	11,540	8,370		3,560	8,830
4.2	1,405				4,410	16,460	940	12,485	8,810		3,850	9,310
4.4	1,630				4,780	17,340	1,070	13,475	9,250		4,140	9,790
4.6	1,870				5,150		1,205	14,530	9,690		4,430	
4.8	2,125				5,520		1,350	15,645	10,130			
5.0	2,395				5,890		1,500	16,875	10,570			
5.2	2,685				6,270		1,650		11,010			
5.4	2,990				6,655				11,450			
5.6	3,300				7,045							
5.8	3,610				7,445							
6.0	3,925				7,845							
6.2	4,245				8,255							
6.4	4,570				8,665							
6.6	4,900				9,075							
6.8	5,240				9,485							
7.0	5,580				9,905							

a Eighty-eight feet should be added to the gage heights for this station, making the first gage height read 88.0 instead of 0.0; the second 88.2 instead of 0.2, and so on.

b Continued: Gage height —1.4, discharge 1,000; gage height —1.20, discharge 1,120; gage height —1.0, discharge 1,295; gage height —0.8, discharge 1,420; gage height —0.6, discharge 1,585; gage height —0.4, discharge 1,760; gage height —0.2, discharge 1,950.

c Continued: Gage height —0.2, discharge 60.

d Continued: Gage height —1.0, discharge 250; gage height —0.8, discharge 370; gage height —0.6, discharge 490; gage height —0.4, discharge 610; gage height —0.2, discharge 780.

Rating tables for stations in Colorado and Kansas.

[Numbers in box heads refer to pages in Water-Supply Papers Nos. 49 and 50.]

Gage height, in feet.	Discharge, in second-feet.											
	South Platte River near Platte Canyon, Colo. (280).	South Platte River at Denver, Colo. (281).	South Platte River at Orchard, Colo. (282).	Bear Creek near Morrison, Colo. (284).	Clear Creek at Forks-creek, Colo. (285).	Boulder Creek near Boulder, Colo. (287).	St. Vrain Creek near Lyons, Colo. (288).	Big Thompson Creek near Arkins, Colo. (290).	Republican River at Junction, Kans. (313).	Solomon River near Niles, Kans. (314).	Saline River near Salina, Kans. (315).	Smoky Hill River at Ellsworth, Kans. (316).
−0.2	a 109	------	------	------	------	------	------	------	------	------	------	------
.0	133	------	------	------	------	------	------	------	------	------	------	------
.2	160	------	------	------	------	------	------	4	------	------	------	------
.4	190	------	------	------	------	22	------	19	------	------	------	------
.6	225	------	------	------	------	47	------	60	------	------	------	------
.8	267	------	------	------	------	77	------	116	------	------	------	15
1.0	317	------	105	9	------	115	------	177	------	------	------	30
1.2	374	------	121	11	------	161	------	239	------	------	------	51
1.4	436	------	139	15	32	220	------	305	------	------	------	77
1.6	505	------	157	19	58	292	------	378	------	------	------	119
1.8	581	------	175	23	93	367	7	461	------	------	------	170
2.0	665	------	196	27	133	444	23	556	------	------	------	228
2.2	754	------	224	31	179	522	64	671	------	------	------	313
2.4	850	------	260	36	235	603	113	813	------	------	------	399
2.6	954	------	340	42	299	688	166	990	130	------	------	485
2.8	1,066	------	614	48	367	778	222	1,190	173	------	------	572
3.0	1,185	------	984	55	441	870	282	1,390	225	------	------	660
3.2	1,305	------	1,354	63	522	------	345	1,590	300	------	------	------
3.4	1,425	------	1,724	71	614	------	412	1,790	400	------	------	------
3.6	1,545	------	2,094	80	719	------	483	1,990	500	------	------	------
3.8	1,665	------	2,464	91	832	------	556	------	610	------	52	------
4.0	1,785	------	2,834	103	946	------	629	------	735	------	60	------
4.2	1,905	------	3,204	116	1,060	------	701	------	890	------	70	------
4.4	2,025	------	3,574	131	1,174	------	774	------	1,065	------	82	------
4.6	2,145	------	3,944	148	1,288	------	846	------	1,275	70	96	------
4.8	2,265	70	4,314	169	1,402	------	918	------	1,500	80	113	------
5.0	2,385	113	4,684	197	------	------	------	------	1,730	100	133	------
5.2	2,505	160	5,054	232	------	------	------	------	1,965	128	145	------
5.4	2,625	213	5,424	271	------	------	------	------	2,205	159	158	------
5.6	2,745	273	5,794	316	------	------	------	------	2,475	193	172	------
5.8	------	341	6,164	367	------	------	------	------	2,775	229	188	------
6.0	------	422	6,534	421	------	------	------	------	3,090	265	206	------
6.2	------	551	6,904	475	------	------	------	------	3,450	303	230	------
6.4	------	727	7,274	529	------	------	------	------	3,875	341	250	------
6.6	------	903	7,644	583	------	------	------	------	4,350	379	265	------
6.8	------	1,079	8,014	637	------	------	------	------	4,875	417	285	------
7.0	------	1,255	8,384	691	------	------	------	------	------	455	305	------
7.2	------	1,433	8,754	------	------	------	------	------	------	493	325	------
7.4	------	1,755	9,124	------	------	------	------	------	------	531	350	------
7.6	------	2,077	9,494	------	------	------	------	------	------	570	370	------
7.8	------	2,399	9,864	------	------	------	------	------	------	610	395	------
8.0	------	2,723	10,234	------	------	------	------	------	------	650	418	------
8.5	------	3,533	11,159	------	------	------	------	------	------	755	482	------
9.0	------	4,348	------	------	------	------	------	------	------	860	542	------
9.5	------	5,163	------	------	------	------	------	------	------	967	615	------
10.0	------	------	------	------	------	------	------	------	------	1,084	685	------
11.0	------	------	------	------	------	------	------	------	------	1,327	835	------
12.0	------	------	------	------	------	------	------	------	------	1,604	1,010	------
13.0	------	------	------	------	------	------	------	------	------	1,900	1,200	------
14.0	------	------	------	------	------	------	------	------	------	2,204	1,405	------
15.0	------	------	------	------	------	------	------	------	------	2,528	1,630	------
16.0	------	------	------	------	------	------	------	------	------	2,884	1,885	------
17.0	------	------	------	------	------	------	------	------	------	3,267	2,165	------
18.0	------	------	------	------	------	------	------	------	------	3,681	2,495	------
19.0	------	------	------	------	------	------	------	------	------	------	2,851	------

a Continued: Gage height −1.0, discharge 33; gage height −0.8, discharge 50; gage height −0.6, discharge 68; gage height −0.4, discharge 87.

Rating tables for stations in Kansas and Colorado.

[Numbers in box heads refer to pages in Water-Supply Paper No. 50.]

Gage height, in feet.	Discharge, in second-feet.										
	Blue River near Manhattan, Kans. (317).	Kansas River at Lecompton, Kans. (318).	Lake Creek at Interlaken station, Twin Lakes, Colo. (320).	Lake Creek below Twin Lakes, Colo. (320).	Arkansas River at Salida, Colo. (322).	Arkansas River near Canyon, Colo. (323).	Arkansas River at Pueblo, Colo. (325).	Arkansas River near Nepesta, Colo. (326).	Arkansas River at Hutchinson, Kans. (330).	Verdigris River near Liberty, Kans. (330).	Neosho River near Iola, Kans. (331).
0.0											
.2			36								
.4			90		106						
.6			155		191				14		
.8			228		284				22		
1.0			308		392				35		
1.2					516				55		
1.4				35	654		174		86		
1.6				55	803		263		134	10	
1.8				82	954		358		210	27	
2.0				125	1,106	194	458		315	55	125
2.2				174	1,260	242	566		424	90	165
2.4				228	1,416	297	680		552	140	220
2.6		3,350		294	1,578	362	799		720	205	292
2.8		3,613			1,746	438	926	154	954	280	385
3.0	150	3,880			1,914	542	1,060	191	1,224	368	510
3.2	200	4,150			2,085	712	1,204	235	1,512	464	650
3.4	270	4,420			2,257	916	1,357	285	1,855	560	810
3.6	340	4,690			2,429	1,135	1,527	346	2,280	660	1,015
3.8	420	4,960			2,601	1,357	1,730	427	2,795	760	1,255
4.0	500	5,230			2,773	1,579	1,973	610	3,385	860	1,520
4.2	590	5,550			2,945	1,801	2,288	974	4,040	960	1,800
4.4	680	5,940			3,117	2,023	2,633	1,337	4,755	1,060	2,100
4.6	770	6,370			3,289	2,245	3,003	1,701	5,600	1,164	2,450
4.8	860	6,840			3,461	2,467	3,373	2,064	6,590	1,280	2,800
5.0	960	7,360			3,633	2,689	3,743	2,428	7,740	1,400	3,150
5.2	1,060	7,960				2,911	4,113	2,791	8,990	1,520	3,500
5.4	1,160	8,570				3,133	4,483	3,155	10,400	1,650	3,850
5.6	1,270	9,200				3,355	4,853	3,518	12,100	1,780	4,200
5.8	1,380	9,850				3,577	5,223	3,882		1,920	4,550
6.0	1,500	10,520				3,799	5,593	4,246		2,060	4,900
6.5	1,825	12,220				4,354	6,518	5,155		2,410	5,775
7.0	2,175	13,920				4,909		6,064		2,760	6,650
7.5	2,560	15,635						6,973		3,115	7,525
8.0	2,970	17,350						7,782		3,480	8,400
8.5	3,400	19,065						8,691		3,850	9,275
9.0	3,850	20,780						9,600		4,225	10,150
9.5	4,315	22,495								4,600	11,025
10.0	4,800	24,210								5,000	11,950
10.5	5,325									5,400	12,950
11.0	5,870									5,801	13,950
12.0	7,000									6,619	15,950
13.0	8,240									7,458	17,960
14.0	9,860									8,300	20,010
15.0	12,030									9,150	22,060
16.0	14,280									10,100	24,120
17.0	16,530									11,150	26,220
18.0	18,780									12,300	28,370
19.0	21,030									13,500	
20.0	23,280									14,700	
22.0	27,780									17,150	
28.0										25,500	
30.0										28,300	
32.0										31,100	
34.0										33,950	
36.0										36,950	

Rating tables for stations in Colorado, Wyoming, and Utah.

[Numbers in box heads refer to pages in Water-Supply Paper No. 50.]

Gage height, in feet.	Discharge, in second-feet.										
	Rio Grande near Del Norte, Colo. (347).	Conejos River near Los Mogotes, Colo. (348).	Rio Grande at Cenicero, Colo. (348).	Black Fork of Green River near Granger, Wyo. (367).	Ashley Creek near Vernal, Utah (368).	Uinta River near Whiterocks, Utah (369).	Whiterocks River near Whiterocks, Utah (369).	Uinta River at Fort Duchesne, Utah (370).	Uinta River at Fort Duchesne, Utah (370).	Uinta River at Ouray School, Utah (371).	Duchesne River at Price road bridge, Utah (373).
−0.2				27				(a)	(b)	28	
.0				55						40	
.2				100						56	
.4				190	32					92	
.6				310	43					134	
.8			22	430	72	115	36			179	
1.0			43	550	112	155	61			221	
1.2	140		79	670	152	260	97			263	
1.4	258		142	810	200	370	135			309	
1.6	384		236	970	260	515	195			375	
1.8	518	251	414	1,130	322	695	286			463	
2.0	660	331	594	1,290	387	875	377		8	551	
2.2	812	419	774	1,450	452	1,055	468		25	639	
2.4	978	522	954	1,610	517	1,235	559	85	55	727	
2.6	1,149	638	1,134	1,770	582		650	128	90	815	
2.8	1,329		1,314	1,930	647		741	175	140	903	
3.0	1,522		1,494	2,090	712		832	265	230	991	
3.2	1,734		1,674		777		923	375	350	1,079	
3.4	1,968		1,854		842		1,014	485	475	1,167	
3.6	2,216		2,034		907		1,105	680	680	1,255	
3.8	2,478		2,214		972		1,196	940	940	1,343	
4.0	2,754		2,394					1,270		1,431	
4.2	3,054		2,574					1,660			
4.4	3,354		2,754					2,050			
4.6	3,654		2,934					2,440			
4.8	3,954		3,114					2,830			
5.0	4,254		3,294								255
5.2	4,554										300
5.4	4,854										370
5.6	5,154										480
5.8	5,454										600
6.0	5,754										740
6.2											900
6.4											1,070
6.6											1,280
6.8											1,520
7.0											1,770
7.2											2,050
7.4											2,370
7.6											2,730
7.8											3,090
8.0											3,450
8.2											3,810
8.4											4,170
8.6											4,530
8.8											4,890
9.0											5,250
9.2											5,610
9.4											5,970
9.6											6,330
9.8											6,690

a Applicable from September 1, 1899, to May 31, 1900.
b Applicable from June 1, 1900, to December 31, 1900.

Rating tables for stations in Colorado, Arizona, Nevada, and California.

[Numbers in box heads refer to pages in Water-Supply Papers Nos. 50 and 51.]

Gage height, in feet.	Discharge, in second-feet.											
	Grand River at Glenwood Springs, Colo. (375).	Gunnison River at Iola, Colo. (378).	Uncompahgre River at Montrose, Colo. (379).	Dolores River at Dolores, Colo. (380).	Los Pinos River at Ignacio, Colo. (382).	Animas River at Durango, Colo. (383).	Gila River at San Carlos, Ariz. (385).	Humboldt River near Elko, Nev. (386).	South Fork of Humboldt River at Mason's ranch, Nev. (396).	Humboldt River near Golconda, Nev. (397).	Humboldt River near Oreana, Nev. (398).	Truckee River at Tahoe, Cal. (402).
0.0												
.2										3	26	
.4									7	9	37	52
.6			10						24	16	52	72
.8			30						47	24	69	99
1.0			51				14		74	35	88	135
1.2			73				30		105	47	113	177
1.4			96				47		141	62	144	224
1.6			122				77		182	78	182	272
1.8			150				123	7	227	96	228	
2.0		250	183		25		170	22	276	114	284	
2.2		450	219		47		230	43	327	134	351	
2.4		652	257	20	78		320	70	382	156	430	
2.6		854	298	37	141		430	104	439	180		
2.8		1,056	344	82	244		580	144	499	206		
3.0	650	1,258		164	347		770	190	559	235		
3.2	755	1,460		280	450		1,100	240	619	266		
3.4	870	1,664		412	553		1,530	292	679	298		
3.6	1,005	1,871		555	656		2,120	346	740	332		
3.8	1,160	2,080		700	759		2,760	402	801	367		
4.0	1,350	2,295		847	862		3,400	461	862	404		
4.2	1,570	2,513		1,001	965		4,080	525	922	443		
4.4	1,810	2,735		1,160	1,068		4,760	594	983	485		
4.6	2,090	2,962		1,327	1,171		5,440	667	1,045	530		
4.8	2,430	3,191		1,506	1,274		6,120	743	1,106	578		
5.0	2,815	3,423		1,686	1,377		6,800	822	1,168	629		
5.2	3,245	3,658			1,480		7,520	903	1,230	684		
5.4	3,770	3,899					8,240	987	1,292	742		
5.6	4,420	4,142						1,073	1,354	803		
5.8	5,080	4,388						1,166	1,416	868		
6.0	5,740							1,257	1,478	937		
6.2	6,420					122		1,352		1,011		
6.4	7,100					168		1,449		1,093		
6.6	7,800					236		1,550		1,183		
6.8	8,520					310		1,655		1,281		
7.0	9,250					394		1,763		1,387		
7.2	10,000					490		1,873		1,501		
7.4	10,765					601		1,986		1,623		
7.6	11,540					736		2,101		1,753		
7.8	12,345					888		2,218		1,888		
8.0	13,155					1,044		2,339		2,026		
8.2	13,970					1,204				2,164		
8.4	14,800					1,370				2,302		
8.6	15,660					1,545						
8.8	16,520					1,733						
9.0	17,390					1,933						
9.2	18,300					2,138						
9.4	19,240					2,350						
9.6	20,180					2,579						
9.8	21,150					2,817						
10.0	22,140					3,066						
10.2	23,150					3,329						
10.4						3,606						
10.6						3,910						

Rating tables for stations in California, Nevada, Idaho, and Utah.

[Numbers in box heads refer to pages in Water-Supply Paper No. 51.]

Gage height, in feet.	Discharge, in second-feet.											
	Truckee River at Nevada-California State line (403).	Truckee River at Vista, Nev. (404).	Steamboat Creek at Steamboat Springs, Nev. (406).	Bear River at Battle-creek, Idaho (409).	Cub River at Franklin, Idaho (410).	Logan River near Logan, Utah (411).	Blacksmith Fork at Hyrum, Utah (412).	Bear River near Collinston, Utah (413).	Weber River near Uinta, Utah (414).	Provo River near Provo, Utah (416).	San Pitch River near Gunnison, Utah (425).	Sevier River near Gunnison, Utah (425).
0.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.4	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	5
.6	.....	.....	8	.....	.....	.....	.....	470	.....	.....	.....	17
.8	.....	.....	14	.....	.....	.....	.....	580	.....	.....	.....	33
1.0	.....	.....	20	.....	.....	.....	.....	690	.....	.....	.....	49
1.2	.....	.....	29	.....	34	.....	.....	815	135	.....	.....	.....
1.4	.....	.....	40	470	42	.....	.....	950	255	.....	.....	.....
1.6	205	16	50	580	51	.....	.....	1,105	375	.....	.....	.....
1.8	264	48	62	705	60	.....	.....	1,275	495	.....	15	.....
2.0	328	105	75	835	68	.....	.....	1,450	615	.....	37	.....
2.2	401	188	.....	995	77	.....	.....	1,650	735	.....	65	.....
2.4	486	283	.....	1,165	.....	110	.....	1,850	855	.....	95	.....
2.6	582	380	.....	1,360	.....	170	.....	2,055	975	.....	.....	.....
2.8	683	479	.....	1,560	.....	245	112	2,280	.....	.....	.....	.....
3.0	788	580	.....	1,760	.....	325	117	2,520	.....	.....	.....	.....
3.2	897	683	.....	1,960	.....	412	147	2,760	.....	.....	.....	.....
3.4	1,010	789	.....	2,170	.....	502	225	3,000	.....	.....	.....	.....
3.6	1,131	898	.....	2,380	.....	603	.....	3,250	.....	.....	.....	.....
3.8	1,264	1,009	.....	2,590	.....	720	.....	3,510	.....	.....	.....	.....
4.0	1,409	1,123	.....	.....	.....	857	.....	3,770	.....	140	.....	.....
4.2	1,566	1,239	.....	.....	.....	1,015	.....	4,050	.....	175	.....	.....
4.4	1,725	1,357	.....	.....	.....	1,185	.....	4,350	.....	225	.....	.....
4.6	1,885	1,477	.....	.....	.....	.....	.....	4,650	.....	285	.....	.....
4.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	355	.....	.....
5.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	430	.....	.....
5.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	530	.....	.....
5.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	645	.....	.....
5.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	788	.....	.....
5.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	962	.....	.....
6.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,136	.....	.....
6.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,310	.....	.....
6.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,484	.....	.....
6.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,658	.....	.....

Rating tables for stations in Idaho, Montana, Washington, and Oregon.

[Numbers in box heads refer to pages in Water-Supply Paper No. 51.]

Gage height, in feet.	Discharge, in second-feet.											
	Boise River near Boise, Idaho (427).	Weiser River near Weiser, Idaho (430).	Blackfoot River near Bonner, Mont. (431).	Missoula River at Missoula, Mont. (432).	Bitterroot River at Missoula, Mont. (433).	Spokane River at Spokane, Wash. (438).	Naches River at North Yakima, Wash. (440).	Yakima River at Union Gap, Wash. (441).	Yakima River at Kiona, Wash. (442).	Palouse River near Hooper, Wash. (443).	Umatilla River at Gibbon, Oreg. (444).	Dungeness River at Dungeness, Wash. (446).
0.0											56	
.1											65	
.2		39									74	
.4		71	581								92	
.6		105	743								124	
.8		150	905								172	
1.0	867	215	1,067			1,341					233	
1.2	1,105	290	1,229		910	1,611					298	
1.4	1,343	375	1,391		1,010	1,897				20	372	
1.6	1,581	470	1,553		1,165	2,199				26	454	
1.8	1,819	585	1,733		1,350	2,517				40	544	
2.0	2,057	720	1,930		1,540	2,851				61	642	
2.2	2,390	875	2,140		1,730	3,201				86	748	
2.4	2,780	1,050	2,390		1,930	3,566				115	862	
2.6	3,170	1,235	2,650		2,160	3,946				148	984	
2.8	3,560	1,425	2,910		2,410	4,340				185	1,114	
3.0	3,950	1,625	3,200		2,680	4,749				226	1,252	213
3.2	4,370	1,840	3,514	1,080	2,960	5,172				271	1,398	225
3.4	4,820	2,075	3,828	1,300	3,260	5,609				320	1,552	249
3.6	5,300	2,325	4,160	1,560	3,570	6,059			566	377	1,714	282
3.8	5,850	2,585	4,592	1,820	3,890	6,523			663	446	1,884	354
4.0	6,400	2,855	5,106	2,100	4,230	7,000		650	780	525	2,061	430
4.2	7,000	3,125	5,620	2,430	4,600	7,489		850	917	620	2,245	520
4.4	7,600	3,395	6,134	2,760	5,000	7,990		1,050	1,074	735	2,435	616
4.6	8,320	3,665	6,648	3,100	5,440	8,503		1,250	1,252	866	2,633	712
4.8	9,060	3,935	7,162	3,500	5,910	9,028		1,450	1,468	998	2,839	[illegible]
5.0	9,800	4,205	7,676	3,900	6,400	9,565	350	1,700	1,705	1,130	3,052	904
5.2	10,540	4,475	8,190	4,400	6,930	10,114	390	1,950	1,962	1,262	3,272	1,000
5.4	11,280	4,745	8,704	4,900	7,500	10,673	470	2,250	2,240	1,394	3,498	1,096
5.6	12,020	5,015	9,218	5,400	8,100	11,243	590	2,600	2,534	1,526	3,730	1,192
5.8	12,760	5,285	9,732	6,000	8,700	11,824	750	3,000	2,842	1,658	3,970	1,288
6.0	13,500	5,555	10,246	6,600	9,300	12,416	910	3,500	3,160	1,790	4,217	1,384
6.2	14,240	5,825		7,300	9,900	13,019	1,090	4,000	3,490	1,922		1,480
6.4	14,980	6,095		8,000	10,500	13,631	1,300	4,500	3,834	2,054		1,576
6.6	15,720	6,365		8,700	11,100	14,253	1,550	5,100	4,190	2,186		1,672
6.8	16,460	6,635		9,400	11,700	14,885	1,840	5,700	4,556	2,318		1,768
7.0	17,200			10,200	12,300	15,525	2,170	6,300	4,935	2,450		1,864
7.2	17,940			11,000	13,000	16,173	2,570	6,900	5,326	2,582		1,960
7.4	18,680			11,800	13,700	16,829	3,010	7,600	5,730	2,714		2,056
7.6	19,420			12,700	14,450	17,493	3,500	8,300	6,143	2,846		2,152
7.8				13,700	15,200	18,165	4,030	9,000	6,565	2,978		2,248
8.0				14,700	16,000	18,845	4,600	9,700	6,995	3,110		2,344
8.2				15,700	16,800	19,533	5,200	10,400	7,436	3,242		2,440
8.4				16,700	17,700	20,228	5,800	11,100	7,890	3,374		2,536
8.6				17,800	18,600	20,928	6,400	11,800	8,354	3,506		2,632
8.8				19,000	19,500	21,636	7,000	12,500	8,830	3,638		2,728
9.0				20,200	20,500	22,351	7,600	13,200	9,320	3,770		2,824
9.2				21,600	21,500	23,073		13,900	9,823	3,902		2,920
9.4				23,200	22,500	23,800		14,600	10,343	4,034		3,016
9.6					23,600	24,531		15,300	10,890	4,166		3,112
9.8					24,700	25,269		16,000	11,457	4,298		3,208
10.0					25,900	26,012		16,700	12,045	4,430		3,304
10.2					27,200	26,759		17,400	12,645	4,562		3,400
10.4					28,600	27,510		18,100	13,245	4,694		3,496
10.6					30,100	28,265		18,800	13,845	4,826		3,592
10.8					31,700	29,024		19,500	14,445	4,958		3,688
11.0					33,500	29,787		20,200	15,045	5,090		3,784
11.2					35,250	30,554		20,900	15,645	5,222		
11.4					37,000	31,325		21,600	16,245	5,354		
11.6					38,750	32,099		22,300	16,845	5,486		
11.8					40,500	32,875		23,000	17,445	5,618		
12.0					42,250	33,653		23,700	18,045	5,750		
12.2									18,645	5,882		
12.6									19,845	6,146		
13.0									21,045	6,410		
13.2									21,645	6,542		
13.6									22,845	6,806		
14.0									24,045	7,070		
14.5									25,545			

Rating tables for stations in Washington and California.

[Numbers in box heads refer to pages in Water-Supply Paper No. 51.]

Gage height, in feet.	Discharge, in second-feet.										
	Elwha River at McDonald, Wash. (447).	Calowa River near Forks, Wash. (448).	Soleduck River near Quillayute, Wash. (449).	Sacramento River at Jellys Ferry, Cal. (450).	Salinas River near Salinas, Cal. (454).	Stanislaus River near Oakdale, Cal. (455).	Tuolumne River at Lagrange, Cal. (456).	San Joaquin River at Herndon, Cal. (458).	San Joaquin River at Herndon, Cal. (458).	King River near Reel Mountain, Cal. (459).	Santa Ana River near Warmsprings, Cal. (475).
1.0	.....	a 330	192	.....	.....	.....	.....	(b)	(c)	.....	.....
1.2	.....	400	230	.....	.....	.....	.....	.....	.....	.....	.....
1.4	.....	485	270	.....	.....	.....	.....	.....	.....	.....	.....
1.6	510	575	310	.....	.....	.....	.....	.....	.....	.....	.....
1.8	550	665	360	.....	.....	.....	.....	.....	.....	.....	10
2.0	610	755	410	.....	.....	.....	.....	.....	.....	.....	14
2.2	690	850	470	.....	.....	.....	.....	60	160	.....	20
2.4	780	950	530	.....	.....	.....	.....	100	200	.....	27
2.6	900	1,050	590	.....	.....	.....	.....	170	300	.....	37
2.8	1,025	1,160	660	.....	.....	.....	.....	280	430	.....	52
3.0	1,175	1,270	730	.....	.....	.....	.....	445	630	.....	71
3.2	1,360	1,380	800	.....	.....	.....	2	640	870	.....	92
3.4	1,647	1,500	880	.....	.....	.....	7	850	1,110	.....	114
3.6	1,973	1,630	960	.....	6	.....	25	1,060	1,350	180	138
3.8	2,299	1,765	1,045	.....	10	.....	45	1,285	1,590	250	163
4.0	2,625	1,910	1,135	2,400	15	.....	85	1,520	1,830	320	190
4.2	2,951	2,070	1,225	2,670	25	30	140	1,765	2,070	400	219
4.4	3,277	2,250	1,325	2,970	40	70	250	2,030	2,310	480	250
4.6	3,603	2,430	1,425	3,290	65	150	410	2,315	2,550	572	.....
4.8	3,929	2,615	1,535	3,630	105	290	570	2,620	2,790	676	.....
5.0	4,255	2,805	1,650	3,980	173	310	750	2,940	3,080	780	.....
5.2	4,581	3,000	1,775	4,360	285	420	950	3,275	3,290	908	.....
5.4	4,907	3,200	1,905	4,760	455	540	1,180	3,620	3,620	1,036	.....
5.6	5,233	3,400	2,050	5,170	650	680	1,440	3,985	3,985	1,170	.....
5.8	5,559	3,600	2,215	5,590	850	820	1,740	4,370	4,370	1,310	.....
6.0	5,885	3,800	2,390	6,030	1,050	960	2,080	4,775	.....	1,450	.....
6.5	6,700	4,300	2,995	7,265	1,725	1,350	3,100	5,850	.....	1,930	.....
7.0	7,515	4,800	3,670	8,635	2,500	1,850	4,320	7,090	.....	2,450	.....
7.5	9,330	5,300	4,345	10,100	3,500	2,410	5,800	8,410	.....	3,120	.....
8.0	9,145	5,800	5,020	11,600	4,750	3,000	7,400	9,730	.....	3,920	.....
8.5	9,960	6,300	5,695	13,100	6,350	3,625	9,000	11,060	.....	4,870	.....
9.0	10,775	6,800	6,370	14,600	8,350	4,350	10,600	12,400	.....	6,000	.....
9.5	11,590	7,300	7,045	16,100	11,000	4,987	12,200	13,750	.....	7,300	.....
10.0	12,405	7,800	7,720	17,600	.....	5,525	13,800	15,110	.....	8,800	.....
11.0	14,035	8,800	9,070	20,800	.....	6,800	17,000	17,870	.....	11,800	.....
12.0	.....	9,800	10,420	24,400	.....	8,075	20,200	20,780	.....	14,800	.....
13.0	.....	10,800	11,770	28,400	.....	9,350	.....	.....	.....	17,800	.....
14.0	.....	.....	.....	32,400	.....	10,625	.....	.....	.....	20,800	.....
15.0	.....	.....	.....	36,800	.....	11,900	.....	.....	.....	.....	.....
16.0	.....	.....	.....	41,600	.....	13,175	.....	.....	.....	.....	.....
17.0	.....	.....	.....	46,600	.....	.....	.....	.....	.....	.....	.....
18.0	.....	.....	.....	52,300	.....	.....	.....	.....	.....	.....	.....
19.0	.....	.....	.....	58,200	.....	.....	.....	.....	.....	.....	.....
20.0	.....	.....	.....	64,200	.....	.....	.....	.....	.....	.....	.....
22.0	.....	.....	.....	76,800	.....	.....	.....	.....	.....	.....	.....
24.0	.....	.....	.....	90,000	.....	.....	.....	.....	.....	.....	.....
26.0	.....	.....	.....	103,200	.....	.....	.....	.....	.....	.....	.....
28.0	.....	.....	.....	116,400	.....	.....	.....	.....	.....	.....	.....
30.0	.....	.....	.....	129,600	.....	.....	.....	.....	.....	.....	.....
32.0	.....	.....	.....	142,800	.....	.....	.....	.....	.....	.....	.....
34.0	.....	.....	.....	156,000	.....	.....	.....	.....	.....	.....	.....
35.0	.....	.....	.....	162,600	.....	.....	.....	.....	.....	.....	.....

a Continued: Gage height −0.4, discharge 70; gage height −0.3, discharge 80; gage height −0.1, discharge 100; gage height 0.0, discharge 110; gage height 0.2, discharge 144; gage height 0.4, discharge 180; gage height 0.6, discharge 225; gage height 0.8, discharge 275.

b Applicable from January 1, 1900, to June 30, 1900; also from November 23, 1900, to December 31, 1900.

c Applicable from July 1, 1900, to November 22, 1900.

DRAINAGE AREAS.

The following table gives the areas of the drainage basins of rivers mentioned in this and other reports of the Division of Hydrography. A similar table was printed in Water-Supply Paper No. 11, pages 95 to 100. Most of the areas have been obtained by planimeter measurement of the best maps available, the topographic atlas sheets of the United States Geological Survey being used for such drainage basins as have been mapped.

Drainage areas of streams in the United States.

		Square miles.
Alabama River at Montgomery, Alabama		13,500
Alabama River at Selma, Alabama		15,400
Allegheny River at Warren, Pennsylvania		3,057
Allegheny River at Oil City, Pennsylvania		4,526
Allegheny River at Parkers Landing, Pennsylvania		6,019
Allegheny River at Mahoning, Pennsylvania		6,964
Allegheny River at Freeport, Pennsylvania		9,219
Allegheny River at Pittsburg, Pennsylvania		16,992
Allegheny River at mouth, Pennsylvania		11,400
Allens Creek (tributary of Genesee River) at mouth, New York		198
American Fork near American Fork, Utah		66
Androscoggin River below junction of Umbagog Outlet and Magalloway River, Maine		1,180
Androscoggin River at Berlin Falls, Maine		1,480
Androscoggin River at Rumford Falls, Maine		2,320
Androscoggin River at Livermore Falls, Maine		2,690
Androscoggin River at Lewiston, Maine		3,120
Androscoggin River at Brunswick, Maine		3,700
Angelica Creek (tributary of Genesee River) at mouth, New York		82
Animas River at Durango, Colorado		812
Antietam Creek at Sharpsburg, Maryland		293
Arkansas River, East Fork, near Leadville, Colorado		44
Arkansas River, Lake Fork, near Leadville, Colorado		21
Arkansas River, Tennessee Fork, near Leadville, Colorado		44
Arkansas River at Granite, Colorado		425
Arkansas River at Salida, Colorado, above South Fork		1,160
Arkansas River at Canyon, Colorado		3,060
Arkansas River at Swallows, Colorado		4,300
Arkansas River at Rock Canyon, Colorado		4,560
Arkansas River at Pueblo, Colorado		4,600
Arkansas River at Nepesta, Colorado		9,130
Arkansas River at Rockyford, Colorado		11,440
Arkansas River at La Junta, Colorado, including Fountain Creek drainage (1,011)		12,200
Arkansas River at Lamar, Colorado		19,367
Arkansas River at Granada, Colorado		23,478
Arkansas River at railroad bridge above Holly, Colorado, including Animas River drainage (3,337)		23,500
Arkansas River at Colorado-Kansas State line		24,600
Arkansas River at Hutchinson, Kansas		34,000
Arkansas River in Colorado	30,720	
Arkansas River in Kansas	7,040	
		37,760

	Square miles.
Ashley Creek (tributary of Green River) at the canyon, Utah	250
Avery Creek (tributary of French Broad River) at bridge on road from Mills River to Asheville, North Carolina	8
Bald Creek (tributary of Nolichucky River) at mouth, North Carolina	15
Bald Mountain Creek 1 mile above mouth, North Carolina	16
Basin Creek (tributary of Caliente Creek), California	96
Battenkill River at mouth, New York	438
Battle Creek at Battlecreek, Michigan	180
Battle Creek at mouth, Michigan	244
Bear Creek at Morrison, Colorado	170
Bear Creek (tributary of Nolichucky River) at Flat Rock, North Carolina	10
Bear Creek (tributary of Holston River) at mouth, Virginia	17
Bear River at Soda Springs, Idaho	3,940
Bear River at Battlecreek, Idaho	4,500
Bear River at Collinston, Utah	6,000
Beards Creek (tributary of Genesee River) at mouth, New York	41
Beaver Creek (tributary of New River) at mouth, North Carolina	16
Beaver Creek (tributary of Nolichucky River) at mouth, near Sprucepine, North Carolina	6
Beaver Dam Creek (tributary of French Broad River) 50 yards above mouth, North Carolina	14
Beaver Dam Creek (tributary of Watauga River) at Leander, North Carolina	21
Beaver Dam Creek (tributary of Holston River) at Damascus, Virginia	57
Beaverkill Creek (tributary of Delaware River) at mouth, New York	322
Beaver River above Beaver, New York	153
Beaver River below Beaver, New York	169
Beaver River at mouth, New York	322
Beech Creek (tributary of Watauga River) above mouth of Fogey Creek, North Carolina	16
Big Bugaboo Creek (tributary of Yadkin River) at ford on road from Roaring River to Elkin, North Carolina	17
Big Elkin Creek (tributary of Yadkin River) at railroad trestle at Elkin, North Carolina	35
Big Goose Creek at Sheridan, Wyoming, below mouth of Little Goose Creek	320
Bighorn River at Thermopolis, Wyoming	8,184
Big Ivy Creek (tributary of French Broad River) one-eighth mile below mouth of Bull Creek, North Carolina	158
Big Laurel Creek (tributary of New River) at mouth, North Carolina	29
Big Pine Creek (tributary of French Broad River) above mouth, North Carolina	16
Big Rock Creek (tributary of Nolichucky River) at ford on Huntdale-Bakersville road, North Carolina	60
Big Sandy Creek at Dadeville, Alabama	195
Big Thompson Creek at Arkins, Colorado	305
Bitterroot River at Missoula, Montana	3,260
Black Creek, Upper (tributary of Genesee River), at mouth, New York	39
Black Creek, Lower (tributary of Genesee River), at mouth, New York	212
Black River at Forestport, New York	268
Black River at Lyons Falls, below Moore River, New York	810
Black River at Carthage, New York	1,741
Black River at Watertown, New York, gaging station	1,889
Black River at mouth, New York	1,930

		Square miles.
Blackfoot River foot marshes in sec. 12, T. 5 S., R. 40 E., Idaho		666
Blackfoot River at Bonner, Montana		2,465
Black Fork of Green River 3 miles west of Granger, Wyoming		1,747
Black Fork of Green River at Granger, Wyoming, including Hams Fork		2,400
Blacksmith Fork at Hyrum, Utah		286
Black Warrior River at Tuscaloosa, Alabama		4,900
Blue River at Manhattan, Kansas		9,490
Blue River in Kansas	2,450	
Blue River in Nebraska	7,040	
		9,490
Boardman River at Traverse, Michigan		295
Boise River at Boise, Idaho		2,450
Boise River at Caldwell, Idaho		3,360
Boone Fork of Watauga River at Shull's mill, North Carolina		9
Boulder Creek at Boulder, Colorado		179
Bowlen Creek (tributary of Nolichucky River) near Burnsville, North Carolina		6
Boylston Creek (tributary of French Broad River) at bridge near mouth, North Carolina		17
Broad River, South Fork, at mouth, Georgia		215
Broad River, North Fork, at Carlton, Georgia		762
Broad River at bridge above mouth of Buffalo Creek, North Carolina		72
Broad River at Gaffney, South Carolina		1,435
Broad River at Alston, South Carolina		4,609
Brown Creek (tributary of Nolichucky River) at ford on Marion-Micaville road, North Carolina		2
Bruneau River at Grandview, Idaho		1,800
Brush Creek (tributary of Watauga River) near Carter, Tennessee		15
Buck Creek (tributary of Catawba River) near mouth, North Carolina		33
Buffalo Creek (tributary of Broad River) at main ford, North Carolina		11
Buffalo Creek (tributary of New River) one-eighth mile above mouth, North Carolina		24
Buffalo Creek (tributary of Watauga River) at mouth, Tennessee		39
Butternut Creek (tributary of Susquehanna River) at mouth, New York		123
Byars Creek (tributary of Holston River) at mouth, Virginia		8
Cache la Poudre River at Fort Collins, Colorado		1,060
Caliente Creek, California:		
Tehachapi Creek	108	
Caliente Creek proper	219	
Basin Creek	96	
		423
Calowa River at Forks, Washington		213
Canadaway Creek, West Branch, above Fredonia, New York		4
Canadian River in Kansas	5,110	
Canadian River in New Mexico	16,900	
Canadian River in Texas	18,620	
		40,630
Canandaigua Outlet at inlet, head of Canandaigua Lake, New York		85
Canandaigua Outlet at foot of Canandaigua Lake, New York		175
Canandaigua Outlet at Phelps, New York		390
Canandaigua Outlet at junction with Mud Creek, New York		431
Canaseraga Creek (tributary of Genesee River) at mouth, New York		259
Cancomgomoc River at entrance into Chesuncook Lake, Maine		230
Caneadea Creek (tributary of Genesee River) at mouth, New York		63

		Square miles.
Cane Creek (tributary of Nolichucky River) one-half mile above mouth, North Carolina		30
Cane Creek (tributary of Catawba River) near mouth, North Carolina		16
Caney Creek (tributary of French Broad River) at bridge near Westfall's place, North Carolina		88
Caney River (tributary of Nolichucky River) near Big Tom Wilson's, North Carolina		21
Caney River (tributary of Nolichucky River) 1½ miles above mouth, North Carolina		148
Caney River (tributary of Nolichucky River) at mouth near Huntdale, North Carolina		158
Canisteo River (tributary of Chemung River) at mouth, New York		780
Cape Fear River at Fayetteville, North Carolina		4,493
Carson River near Empire, Nevada		894
Carson River, East Fork, at Rodenbahs, Nevada		414
Carson River, West Fork, at Woodfords, California		70
Catawba River, North Fork, near mouth, North Carolina		84
Catawba River near Oldfort, North Carolina		12
Catawba River at Morganton, North Carolina		758
Catawba River at Lookout Shoals, North Carolina		1,424
Catawba River at Catawba, North Carolina		1,514
Catawba River at Fort Mill, South Carolina		2,987
Catherines Creek (tributary of Seneca River) at mouth, New York		94
Cathey Creek (tributary of French Broad River) at ford of Brevard-Jeptha road, North Carolina		11
Cattail Branch (tributary of Nolichucky River) near Burnsville, North Carolina		7
Cayadutta Creek below Johnstown, New York, gaging station		40
Cayadutta Creek at mouth, New York		62
Cayuga Inlet (tributary of Cayuga Lake, New York), including Cascadilla Creek		173
Cayuga Lake at outlet, New York		1,593
Cayuta Creek (tributary of Susquehanna River) at mouth, New York		148
Cazenovia Lake at outlet, New York		9
Cedar Creek (tributary of Holston River) at mouth, Virginia		6
Chama River at Abiquiu, New Mexico		2,300
Champlain Lake in New York	2,950	
Champlain Lake in Vermont	4,270	
Champlain Lake in Quebec	740	
Champlain Lake, area of water surface	400	
		8,360
Chattahoochee River at Oakdale, Georgia		1,560
Chattahoochee River at West Point, Georgia		3,300
Charlotte River (tributary of Susquehanna River) at mouth, New York		178
Chautauqua Outlet at Chautauqua Lake, New York		178
Chautauqua Outlet below Cassadaga Creek, New York		343
Cheat River at Uneva, West Virginia		1,375
Cheat River at Rowlesburg, West Virginia		886
Chemung River at junction of Canisteo and Cohocton rivers, New York		1,941
Chemung River at Elmira, New York		2,055
Chemung River at mouth, New York		2,518
Chenango River (tributary of Susquehanna River) above Canasawacta Creek, New York		297

		Square miles.
Chenango River (tributary of Susquehanna River) above Tioughnioga, New York		685
Chenango River (tributary of Susquehanna River) at mouth, New York		1,540
Chenevas Creek (tributary of Susquehanna River) at mouth, New York		127
Chenunda Creek (tributary of Genesee River) at mouth, New York		30
Cherry Valley Creek (tributary of Susquehanna River) at mouth, New York		121
Cheyenne River in Montana	3,750	
Cheyenne River in Nebraska	17,910	
Cheyenne River in North Dakota	39,770	
Cheyenne River in South Dakota	40,840	
Cheyenne River in Wyoming	12,030	
		114,300
Chittenango Creek at Bridgeport, New York, gaging station, including Cazenovia Lake		307
Chittenango Creek at mouth, New York		309
Chowchilla Creek above sec. 1, T. 9 S., R. 18 E., California		268
Cimarron River at Arkalon, Kansas		5,200
Clam Lakes at outlet, Michigan (water surface 6.7 square miles)		67
Clam River at mouth, Michigan		307
Clarion River (tributary of Allegheny River) at Clarion, Pennsylvania		865
Clear Creek 4 miles west of Buffalo, Wyoming		118
Clear Creek at Forkscreek, Colorado, gaging station		345
Clear Creek near Granite, Colorado		72
Clear Creek (tributary of Catawba River) near mouth, North Carolina		3
Clyde River at Lyons, New York, junction of Canandaigua Outlet and Mud Creek		729
Clyde River at Clyde, New York		807
Clyde River at mouth, New York		869
Cobbosseecontee River near Augusta, Maine		230
Cohocton River (tributary of Chemung River) at mouth, New York		425
Cohocton River (tributary of Susquehanna River) at mouth, New York		425
Colbert Creek (tributary of Nolichucky River) at ford on Micaville-Marion road, North Carolina		2
Cold Creek (tributary of Genesee River) at mouth, New York		41
Colorado River at Austin, Texas		37,000
Colorado River in Arizona[1]	56,182	
Colorado River in California[1]	8,610	
Colorado River in Colorado[1]	5,490	
Colorado River in Nevada[1]	3,200	
Colorado River in New Mexico[1]	19,000	
Colorado River in Utah[1]	21,633	
		114,115
Colorado River at Yuma, Arizona		225,049
Columbia River in Idaho	7,880	
Columbia River in Oregon	24,093	
Columbia River in Montana	25,000	
Columbia River in Washington	26,160	
		81,133
Conasauga River at mouth, New York		723
Conejos River at Los Mogotes, Colorado		282
Conejos River at Conejos, Colorado		333

[1] Not including Grand, Green, nor Gila basins.

	Square miles.
Conesus Lake (tributary of Genesee River) at mouth, New York	89
Connecticut River at Holyoke, Massachusetts	8,660
Connecticut River at Hartford, Connecticut	10,234
Conemaugh River (tributary of Allegheny River) at Saltsburg, Pennsylvania	1,403
Conemaugh River (tributary of Allegheny River) at Johnstown, Pennsylvania	711
Coosa River at Rome, Georgia	4,006
Coosa River at Lock No. 4, Alabama	7,053
Coosa River at Riverside, Alabama	7,065
Coosa River at Lock No. 5, Alabama	7,648
Coosawattee River at Carters, Georgia	531
Coosawattee River at mouth, Georgia	885
Coquago Creek (tributary of Delaware River) at mouth, New York	82
Coshaqua Creek (tributary of Genesee River) at mouth, New York	82
Cottonwood Creek, South Fork, near Buena Vista, Colorado	28
Cottonwood Creek, Middle Fork, near Buena Vista, Colorado	37
Cove Creek (tributary of Green River) near mouth, North Carolina	7
Cove Creek (tributary of Watauga River) at mouth, North Carolina	39
Cove Creek (tributary of Broad River) at bridge on Rutherfordton road, North Carolina	78
Crabtree Creek (tributary of Nolichucky River) at ford on Burnsville-Sprucepine road, North Carolina	20
Crawford Creek (tributary of Genesee River) at mouth, New York	12
Crib Creek (tributary of Catawba River) near mouth, North Carolina	10
Croton River at old Croton Dam, New York	338
Croton River at new Croton Dam, New York	360
Cryder Creek (tributary of Genesee River) at mouth, New York	43
Cub River at Franklin, Idaho	53
Curtis Creek (tributary of Catawba River) near mouth, North Carolina	11
Dan River at South Boston, Virginia	2,750
Dan River at Clarksville, Virginia	3,798
Davidson River (tributary of French Broad River) at county bridge near mouth, North Carolina	48
Dead River at mouth, Maine	1,000
Deep River at Cumnock, North Carolina	1,110
Deep River at Moncure, North Carolina	1,400
Deer River (tributary of Black River) at mouth, New York	107
Delaware River, West Branch, at Deposit, below Coquago (Oquago) Creek, New York	519
Delaware River, West Branch, at mouth, New York	685
Delaware River above the mouth of Beaver Kill, New York	520
Delaware River below junction of East and West branches, New York	1,604
Delaware River below Port Jervis, New York	3,252
Delaware River below mouth of Neversink River, New York	3,600
Delaware River at Pennsylvania State line	2,580
Delaware River at Delaware Water Gap, Pennsylvania	4,176
Delaware River at Lambertville, New Jersey	6,855
Delaware River at mouth, Wilmington, Delaware	11,895
Denton Valley Creek (tributary of Holston River) at mouth, Virginia	12
Deschutes River at Moro, Oregon	9,900
Desplaines River at Riverside, Illinois	633
Doe Creek (tributary of Watauga River) one-half mile above mouth, Tennessee	43

	Square miles.
Doe River (tributary of Watauga River) 1 mile above Elizabethton, Tennessee	140
Doe River (tributary of Watauga River) at Allentown, Tennessee	72
Dolores River, West Fork, Colorado	160
Dolores River at Dolores, Colorado, gaging station	524
Dolores River at Dolores, Colorado, including Lost Canyon Creek (59)	583
Dolores River at intake of ditch system, Colorado	586
Dowagiac River (tributary of St. Joseph River) at mouth, Michigan	281
Dry Gulch Creek (tributary of Duchesne River) at mouth, Utah	260
Duchesne River above Strawberry Creek, Utah	703
Duchesne River at Lake Fork, Utah	2,247
Duchesne River at Price road bridge, Utah	2,746
Duchesne River at mouth, Utah	3,985
Dungeness River at Sequim, Washington, gaging station	145
Dutch Creek (tributary of Watauga River) at Valle Cruces, North Carolina	11
Dykes Creek at mouth, New York	68
East branch or fork of any river, *see* the river.	
East Canada Creek at Dolgeville, New York	256
East Canada Creek at mouth, New York	283
Eaton Brook (tributary of Chenango River) at mouth, New York	11
Elk Creek (tributary of New River) at Elk crossroads, North Carolina	10
Elk Creek (tributary of New River) 200 yards above mouth, Virginia	82
Elk Creek, North Fork, at Banners Elk, North Carolina	4
Elk Creek, South Fork, at Banners Elk, North Carolina	7
Elk Creek (tributary of Watauga River) at Lineback, Tennessee	80
Elk Creek (tributary of Yadkin River) one-fourth mile above ford, North Carolina	52
Elk Fork Creek (tributary of Nolichucky River) near Big Tom Wilson's, North Carolina	3
Elkhart River at mouth, Indiana	500
Elkhorn River at Norfolk, Nebraska	2,474
Elkhorn River at Arlington, Nebraska	5,980
Elwha River at McDonald, Washington	188
Etowah River at Canton, Georgia	604
Etowah River at mouth, Rome, Georgia	1,854
Fall Creek, New York (tributary of Cayuga Lake), not including Cascadilla Creek	152
Fall River 5 miles above mouth, Idaho	594
Farm Creek (tributary of Duchesne River) at canyon, Utah	47
Fifteenmile Creek (tributary of Holston River) at mouth, Virginia	13
Fish Creek, East Branch, above Point Rock, New York	104
Fish Creek, West Branch, at McConnellsville, New York	187
Fish Creek (tributary of Oneida River) at junction with Hudson River, New York	253
Fish Creek (tributary of Oneida River) at mouth, New York	480
Fisher River (tributary of Yadkin River) at railroad trestle, North Carolina	155
Flannery Fork (tributary of New River) at ford on Boone River-Blowing Rock road, North Carolina	6
Flat Creek (tributary of Swannanoa River) 2 miles below Black Mountain Station, North Carolina	18
Flat Creek (tributary of French Broad River) at mouth, North Carolina	25
Flat River (tributary of Grand River) at mouth, Michigan	602

	Square miles.
Flint River at Molena, Georgia	992
Flint River at Woodbury, Georgia	988
Flint River at Albany, Georgia	5,000
Florida River at Stewart's ranch, 9 miles from Durango, Colorado	136
Fogey Creek (tributary of Watauga River) at mouth, North Carolina	8
Forge Creek (tributary of Watauga River) near mouth, Tennessee	18
Fort Tejon Creek, California, including Cuddy Creek and Castac Lake (upper basin, 56)	93
Fox Creek (tributary of New River) one-fourth mile above mouth, Virginia	60
French Broad River, North Fork, above mouth of West Fork, North Carolina	36
French Broad River at crossing of Brevard-Webster road, North Carolina	26
French Broad River at ford on road between Tucker and Shoal creeks, North Carolina	19
French Broad River, East Fork, near mouth, North Carolina	26
French Broad River, Middle Fork, at bridge above ford, North Carolina	5
French Broad River, West Fork, at bridge near mouth, North Carolina	30
French Broad River at Eastatoe Bridge, North Carolina	67
French Broad River at bridge near Carson Creek, North Carolina	133
French Broad River at Penrose, North Carolina	294
French Broad River at Fanning Bridge, North Carolina	644
French Broad River at Asheville, North Carolina	987
French Broad River at Oldtown, Tennessee	1,737
French Broad River at mouth, Tennessee	5,133
Frenchman River at Wauneta, Nebraska	989
Frenchman River at Palisade, Nebraska	1,032
Fulton Chain above Old Forge, New York	41
Gallatin River at Logan, Montana	1,620
Gap Creek (tributary of New River) at mouth, North Carolina	11
Gap Creek (tributary of Watauga River) at mouth, Tennessee	10
Garoga Creek 3 miles above Mohawk River, New York	81
Genesee River below Cryder Creek, New York	143
Genesee River below Chenunda Creek, New York	211
Genesee River below Dykes Creek, New York	282
Genesee River below Vandemarck Creek, New York	323
Genesee River below Knights Creek, New York	346
Genesee River below Phillips Creek, New York	405
Genesee River below Van Campens Creek, New York	466
Genesee River below Angelica Creek, New York	563
Genesee River below White Creek, New York	585
Genesee River below Upper Black Creek, New York	627
Genesee River below Crawford Creek, New York	649
Genesee River below Caneadea Creek, New York	714
Genesee River below Cold Creek, New York	786
Genesee River below Rush Creek, New York	822
Genesee River below Wiscoy Creek, New York	942
Genesee River below Wolf Creek, New York	994
Genesee River below Silver Lake Creek, New York	1,060
Genesee River at Mount Morris, New York	1,070
Genesee River below Coshaqua Creek, New York	1,142
Genesee River below Canaseraga Creek, New York	1,407
Genesee River below Beards Creek, New York	1,464
Genesee River below Conesus Lake, New York	1,644

		Square miles.
Genesee River below Honeoye Creek, New York		1,939
Genesee River below Allens Creek, New York		2,145
Genesee River at Rochester, New York		2,365
Genesee River at mouth, New York		2,446
Genesee River below Black Creek, New York		2,380
Gila River at San Carlos, Arizona		13,455
Gila River at Buttes, Arizona		17,834
Gila River in Arizona, including small lost basins	56,838	
Gila River in New Mexico, including small lost basins	14,300	
		71,138
Goose Creek at Lake Cheesman, Colorado, gaging station		86
Grand River at Glenwood Springs, Colorado		5,838
Grand River at Grand Junction, Colorado, above Gunnison River		8,644
Grand River at Grand Junction, Colorado, below Gunnison River, including Uncompahgre (497) and Gunnison at mouth (7,935)		16,579
Grand River in Colorado	22,294	
Grand River in Utah	3,873	
		26,167
Grand River above Lansing, Michigan		756
Grand River at North Lansing dam, Michigan		1,168
Grand River below mouth of Red Cedar River, Michigan		1,229
Grand River at North Lansing, Michigan		1,238
Grand River above Portland, Michigan		1,404
Grand River below mouth of Lookingglass River, Michigan		1,710
Grand River above Lyons, Michigan		1,748
Grand River below mouth of Maple River, Michigan		2,667
Grand River at Ionia, Michigan		2,918
Grand River above Lovell, Michigan		2,971
Grand River below mouth of Flat River, Michigan		3,573
Grand River above Grand Rapids, Michigan		4,883
Grand River at C. and W. M. R. R. bridge, Grand Rapids, Michigan		4,900
Grand River at Brick House, Michigan, gaging station		4,961
Grand River at Lamont, Michigan		5,179
Grand River above mouth, Michigan		5,572
Grand Encampment Creek at Peryam's ranch, near Encampment, Wyoming		252
Grassy Creek (tributary of Nolichucky River) near Sprucepine, North Carolina		12
Great Basin in California	47,240	
Great Basin in Idaho	3,420	
Great Basin in Nevada	102,220	
Great Basin in Oregon	18,950	
Great Basin in Utah	43,548	
Great Basin in Wyoming	1,494	
		216,872
Great Lakes:		
Superior	80,400	
Michigan	68,100	
Huron	75,300	
St. Clair	6,815	
Erie	34,480	
Ontario	32,980	
		298,075
Great Salt Lake, Utah		2,280
Green River (tributary of Broad River) at Cox's bridge, North Carolina		200

		Square miles.
Green River (tributary of Broad River) near Saluda, North Carolina		51
Green River at Greenriver, Wyoming		7,450
Green River at Blake, Utah		38,200
Green River in Colorado	10,332	
Green River in Utah	15,916	
Green River in Wyoming	20,977	
		47,225
Green River, Black Fork, at Granger, Wyoming		2,400
Greenbrier River at Alderson, West Virginia		1,344
Greenbrier River at mouth, West Virginia		1,575
Grey Bull River at Meteetse, Wyoming		870
Grose Creek (tributary of Holston River) at mouth, Virginia		3
Gunnison River at Iola, Colorado		2,298
Gunnison River at Grand Junction, Colorado		7,935
Gunpowder River at Baltimore conduit, Maryland		294
Halls Creek (tributary of Holston River) at mouth, Virginia		14
Haw River at Moncure, North Carolina		1,800
Hemlock Lake (tributary of Genesee River) at outlet, New York		48
Henry Fork 1 mile above mouth of Fall River, Idaho		931
Henson Creek (tributary of Nolichucky River) at mouth, North Carolina		7
Hickorynut Creek (tributary of Broad River) at mouth, North Carolina		8
Higgins Lake, Michigan (water surface 15 square miles)		67
Hillabee Creek at Alexander City, Alabama		214
Hiwassee River at Murphy, North Carolina		410
Hiwassee River at Reliance, Tennessee		1,180
Hiwassee River at Charleston, Tennessee		2,297
Hiwassee River at mouth, Tennessee		2,698
Hogthief Creek (tributary of Holston River) at mouth, Virginia		6
Hogtrough Creek (tributary of Holston River) at mouth, Virginia		6
Hollow Poplar Creek (tributary of Nolichucky River) at ford on Erwin-Bakersville road, North Carolina		9
Holston River, South Fork, below mouth of Middle Fork, Virginia		582
Holston River, South Fork, at Bluff City, Tennessee		828
Holston River, South Fork, below mouth of Laurel Fork, Virginia		336
Holston River, South Fork, above mouth of Laurel Fork, Virginia		160
Holston River, South Fork, at Rye Valley, Virginia		37
Holston River, Middle Fork, 5 miles above mouth at Shallow Ford, Virginia		227
Holston River, Middle Fork, above mouth of Bear Creek, Virginia, near Marion, Virginia		33
Holston River at mouth, Tennessee		3,790
Hominy Creek (tributary of French Broad River) at Asheville, North Carolina		104
Honeoye Creek (tributary of Genesee River) at mouth, New York		263
Hood River at Tucker, Oregon		350
Hood River at mouth, Oregon		418
Hoosic River (tributary of Hudson River) at mouth, New York		730
Horse Creek (tributary of New River) one-fourth mile above mouth, North Carolina		56
Horse Creek (tributary of Nolichucky River) at mouth, North Carolina		6
Houghton Lake, Michigan (water surface 31 square miles)		185
Hubbard Lake, Michigan (water surface 134 square miles)		148
Hudson River at Glens Falls, New York		2,800
Hudson River at Mechanicsville, New York		4,500

		Square miles.
Hudson River at Troy, New York		8,000
Hudson River at Hadley, New York		1,092
Humboldt River at Elko, Nevada		2,840
Humboldt River at Battle Mountain, Nevada		7,800
Humboldt River at Golconda, Nevada		10,780
Humboldt River at Oreana, Nevada		13,800
Humboldt River at Oreana, Nevada, including Grassy Valley		14,967
Humboldt River, North Fork, at Peko, Nevada		1,020
Humboldt River, South Fork, at Mason's ranch, Nevada		1,150
Hungry Mother Creek (tributary of Holston River) at ford near Marion, Virginia		16
Huron River at mouth, Michigan		950
Huttons Branch (tributary of Holston River) at mouth, Virginia		14
Independence Creek (tributary of Black River) at mouth, New York		90
Indian Lake at gaging station, New York		146
Jack Creek (tributary of Nolichucky River) at mouth, North Carolina		22
James River at Buchanan, Virginia		2,058
James River at Balcony Falls, Virginia		3,027
James River at Cartersville, Virginia		6,332
Jarrett Creek (tributary of Catawba River) near mouth, North Carolina		6
Jefferson River at Sappington, Montana		8,984
Jefferson River at Threeforks, Montana		9,400
Jim Scott Branch (tributary of Holston River) at mouth, Virginia		2
Johns River (tributary of Catawba River) on highway bridge near Morganton, North Carolina		213
Johns River (tributary of Catawba River) at Collettsville, North Carolina		70
Jones Falls at Baltimore conduit, Maryland		38
Juniata River at Newport, Pennsylvania		3,476
Juniata River at mouth, Pennsylvania		3,530
Kalamazoo River, North Branch, at Albion, Michigan		138
Kalamazoo River, South Branch, at Albion, Michigan		136
Kalamazoo River at Marengo dam, Michigan		261
Kalamazoo River below junction of North and South branches		274
Kalamazoo River at Marshall, Michigan		443
Kalamazoo River above Battlecreek, Michigan		603
Kalamazoo River below Battlecreek, Michigan		847
Kalamazoo River at Plainville, Michigan		1,307
Kalamazoo River at Allegan, Michigan		1,508
Kalamazoo River at mouth, Michigan		2,064
Kalawa River. *See* Calowa River.		
Kansas River at Lecompton, Kansas		58,550
Kansas River at Lawrence, Kansas		59,841
Kansas River in Kansas	34,526	
Kansas River in Nebraska	17,455	
Kansas River in Colorado	9,459	
		61,440
Kaweah River above sec. 3, T. 18 S., R. 27 E., California		619
Kennebec River at outlet of Moosehead Lake, Maine		1,250
Kennebec River below mouth of Dead River, Maine		2,570
Kennebec River at Carritunk Falls, Maine		2,900
Kennebec River at Madison, Maine		3,330
Kennebec River at Norridgewock, Maine		4,030
Kennebec River at Somerset Mills, Maine		4,380
Kennebec River at Waterville, Maine, above mouth of Sebasticook River		4,410

	Square miles.
Kennebec River at Waterville, Maine, below mouth of Sebasticook River	5,470
Kennebec River at Augusta, Maine	5,770
Kennebec River at mouth, Maine	6,330
Kentucky Fork of North Toe River at mouth, North Carolina	4
Kern River at First Point of Measurement, above Bakersfield, California, including North Fork (1,115), South Fork (1,050), and Lower Basin (180)	2,345
Keuka Lake Outlet at foot of Keuka Lake, New York	187
Keuka Lake at outlet, New York	213
King Creek (tributary of French Broad River) on Brevard road, North Carolina	8
King River at Red Mountain, California	1,775
Knights Creek (tributary of Genesee River) at mouth, New York	22
Lake Creek at Twin Lakes, Colorado	109
Lake Creek at Interlaken station (between Twin Lakes), Colorado	104
Lake Erie	34,480
Lake Fork (tributary of Duchesne River) at mouth, Utah	475
Lake George at outlet, New York, including area of water surface (50)	238
Lake Huron	80.400
Lake Michigan	68,100
Lake Ontario	32,980
Lake St. Clair	6,815
Lake Superior	75,300
Laramie River above Woods Landing, Wyoming (in Colorado, 343)	435
Laramie River at Uva, Wyoming, including 428 square miles in Colorado	3,179
Laramie River at mouth, Fort Laramie, Wyoming, not including 500 square miles of lost drainage of James Lake, Cooper Lake, etc	4,076
Laurel Creek (tributary of French Broad River) above mouth, North Carolina	136
Laurel Creek, Upper (tributary to Watauga River), at mouth, North Carolina	7
Laurel Creek, Lower (tributary of Watauga River), at mouth, North Carolina	7
Laurel Fork of Doe River at Allentown, Tennessee	26
Laurel Fork of Holston River 1 mile below Damascus, Virginia	172
Lees Creek (tributary of French Broad River) at Olivette, North Carolina	5
Linville River at Linville Falls, North Carolina	46
Linville River at mouth, North Carolina	87
Little River (tributary of French Broad River) at bridge three-fourths mile above mouth, North Carolina	59
Little River (tributary of New River) at ford on Independence–Oldtown road, Virginia	134
Little Androscoggin River at mouth, Maine	380
Little Bald Mountain Creek at mouth, North Carolina	3
Little Crabtree Creek (tributary of Nolichucky River) above lower ford on Micaville–Sprucepine road, North Carolina	19
Little Delaware Creek (tributary of Delaware River) near mouth, New York	53
Little Doe River (tributary of Watauga River) at Allentown, Tennessee	31
Little Goose Creek at Sheridan, Wyoming	128
Little Patuxent River at mouth, Maryland	139

	Square miles.
Little Pine Creek (tributary of French Broad River) above mouth, North Carolina	15
Littlerock Creek at head of South Antelope Valley Irrigation Company's canal, near Palmdale, California	78
Little Tennessee River at Judson, North Carolina	682
Little Truckee River at Boca, California	171
Little Wood River at Toponis, Idaho	1,270
Locust Creek (tributary of Nolichucky River) at mouth, North Carolina	6
Logan River at Logan, Utah	218
Lookingglass River (tributary of Grand River) at mouth, Michigan	306
Los Angeles River above Devils Gate reservoir site, California	28
Los Angeles River above Narrows at Burbank, California, including Tujunga Canyon (116), Arroyo Seco Canyon (18.1), Millard Canyon (3.1), Eaton Canyon (6.5), Little Santa Anita Canyon (2.5), and Santa Anita Canyon (11.1)	470
Los Pinos River at north line of Southern Ute Indian Reservation, Colorado	321
Los Pinos River at Ignacio Agency, Colorado	450
Los Pinos River at mouth, Colorado	650
Loup River at Columbus, Nebraska	13,542
Lovell Creek (tributary of Black River) at mouth, New York	34
Lower Creek (tributary of Catawba River) near Morganton, North Carolina	87
Lower Black Creek (tributary of Genesee River) at mouth, New York	212
Lower Laurel Creek (tributary of Watauga River) at mouth, North Carolina	7
Madison Brook (tributary of Chenango River) at mouth, New York	9
Madison River at Redbluff, Montana	2,085
Madison River at Threeforks, Montana	2,420
Magolloway River at mouth, Maine	420
Malade River at Toponis, Idaho	2,190
Malade River at Bliss, Idaho	3,550
Malheur River at Vale, Oregon	9,900
Mancos River at Mancos, Colorado	117
Mancos River at mouth, Colorado	855
Manti Creek at Manti, Utah	31
Maple Creek (tributary of Broad River) on bridge near mouth, North Carolina	13
Maple River above Maple Rapids, Michigan	459
Maple River at mouth, Michigan	919
Martin Creek (tributary of Nolichucky River) near Erwin, Tennessee	6
Martins Creek (tributary of Black River) at mouth, New York	29
Mattawamkeag River below outlet of Baskahegan Lake, Maine	190
Mattawamkeag River at mouth, Maine	1,530
Meat Camp Creek (tributary of New River) one-fourth mile below Moretz, North Carolina	19
Medicine River at Kiowa, Kansas	1,300
Merced River at Merced Falls, California	1,076
Merrimac River at Lawrence, Massachusetts	4,553
Messalonskee River at mouth, Maine	205
Middle Branch of any river, *see* the river.	
Middle Creek near Bozeman, Montana	55
Middle Creek (tributary of Nolichucky River) at ford on Micaville-Marion road, North Carolina	2

		Square miles.
Middle Fork of any river, *see* the river.		
Middle Loup River at St. Paul, Nebraska		6,849
Middle Saluda Creek 1 mile above mouth, North Carolina		54
Milk River at Havre, Montana, including Bad Water Lake		7,300
Mill Creek at Crafton, California		47
Mill Creek (tributary of Holston River) 1 mile above mouth, Virginia		7
Mill Creek (tributary of Catawba River) near mouth, North Carolina		16
Mills River (tributary of French Broad River) on Old Haywood road, North Carolina		73
Mississippi River at St. Paul, Minnesota, including Minnesota River (16,350)		36,085
Missoula River at Missoula, Montana		5,960
Missouri River at Townsend, Montana		14,500
Missouri River at Canyon Ferry, Montana		15,036
Missouri River at Craig, Montana		17,615
Missouri River in Montana	81,018	
Missouri River in Wyoming	760	
		81,778
Mitchell River (tributary of Yadkin River) at railroad trestle, North Carolina		118
Mohave River at Victorville, California		400
Mohawk River at Ridge Mills, New York		153
Mohawk River at Rome, New York		184
Mohawk River at Utica, New York		524
Mohawk River at Little Falls, New York		1,306
Mohawk River below mouth of Schoharie Creek, New York		3,100
Mohawk River at Freeman's bridge, Schenectady, New York		3,212
Mohawk River at State dam, Rexford Flats, New York		3,385
Mohawk River at mouth, New York		3,468
Monocacy River at Frederick, Maryland		665
Monocacy River at mouth, Maryland		941
Monongahela River at Weston, West Virginia		140
Monongahela River at Fairmont, West Virginia		2,324
Monongahela River at Morgantown, West Virginia		2,749
Monongahela River at Greensboro, Pennsylvania		4,574
Monongahela River at Lock No. 4, Pennsylvania		5,427
Moody Mill Creek (tributary of Watauga River) at mouth, North Carolina		3
Moose River at outlet into Moosehead Lake, Maine		1,250
Moose River (tributary of Black River) at cable station, New York		346
Moose River (tributary of Black River) at mouth, New York		406
Mud Creek (tributary of French Broad River) at road crossing near mouth, North Carolina		116
Mud Creek (tributary of Clyde River) at Lyons, New York		298
Muddy Creek (tributary of Catawba River) near mouth, North Carolina		67
Mulberry Creek (tributary of Johns River) at Collettsville, North Carolina		32
Mulberry Creek (tributary of New River) at mouth, North Carolina		35
Mulberry River (tributary of Yadkin River) at railroad trestle, North Carolina		44
Muskegon River above Clam River, Michigan		787
Muskegon River below Clam River, Michigan		1,094
Muskegon River above Big Rapids, Michigan		1,764

	miles.
Muskegon River above Newaygo, Michigan	2,352
Muskegon River above mouth, Michigan	2,663
Muskingum River at Zanesville, Ohio	5,828
Muskrat Lake and group, Michigan (water surface 8 square miles)	57
Nantahala River at mouth, North Carolina	193
Naches River at North Yakima, Washington	1,000
Neatahwanta Lake at outlet, New York	23
Neosho River at Iola, Kansas	3,670
Neshaminy Creek below the forks, Pennsylvania	139
Neuse River at Selma, North Carolina	1,175
Neversink River (tributary of Delaware River) near mouth, New York	346
Newfound Creek (tributary of French Broad River) three-fourths mile above mouth, North Carolina	33
Newfound Creek (tributary of French Broad River) at mouth, North Carolina	34
New River, North Fork, at Weaversford, North Carolina	278
New River, North Fork, 1 mile below Creston, North Carolina	65
New River, South Fork, at New River, North Carolina	327
New River, South Fork, at Riverside, North Carolina	102
New River, East Fork, at ford on Boone-Aho road, North Carolina	6
New River, Middle Fork, at ford on Boone-Aho road, North Carolina	14
New River at Oldtown, Virginia	1,100
New River at Radford, Virginia	2,725
New River above Greenbrier River, West Virginia	4,523
New River at Hinton, West Virginia	5,600
New River at Fayette, West Virginia	6,200
Ninemile Creek 1 mile below Stittville, New York, gaging station	63
Ninemile Creek at mouth, New York	74
Niobrara River at Fort Niobrara, Nebraska	6,300
Nolichucky River above Tennessee State line	640
Nolichucky River at Chucky Valley, Tennessee	817
North (of James) River at East Glasgow, Virginia	831
North Boulder Creek near Boulder, Colorado	102
North Branch of any river, *see* the river.	
North Broad River at Carlton, Georgia	763
North Fork of any river, *see* the river.	
North Indian Creek (tributary of Nolichucky River) at Erwin, Tennessee	61
North Loup River at St. Paul, Nebraska	4,024
North Platte River above Sweetwater River, including 1,696 in Colorado	7,668
North Platte River above Douglas, Wyoming	14,255
North Platte River above Orin Junction, Wyoming	14,828
North Platte River at Guernsey, Wyoming	16,243
North Platte River above Fort Laramie, Wyoming	16,416
North Platte River below Laramie River, Wyoming	20,492
North Platte River in Wyoming and Colorado	23,643
North Platte River at Gering, Nebraska	24,340
North Platte River at Camp Clarke, Nebraska	24,830
North Platte River at North Platte, Nebraska	28,517
North Saluda Creek 2 miles below Humphrey's store, North Carolina	18
North Saluda Creek at ford on Lima-Cleveland Mills road, North Carolina	42
North Saluda Creek at iron bridge at Marietta, North Carolina	59
North Toe River (tributary of Nolichucky River) at Sprucepine, North Carolina	128

	Square miles.
North Toe River (tributary of Nolichucky River) at ford on Linnville-Cranberry road, North Carolina	9
North Toe River, Kentucky Fork of, at mouth, North Carolina	4
Nottely River at Ranger, North Carolina	272
Oak Creek (tributary of Susquehanna River) at mouth, New York	115
Oaliout Creek (tributary of Susquehanna River) at mouth, New York	115
Oatka Creek at Warsaw, New York	28
Ocmulgee River at Macon, Georgia	2,425
Oconee River at Carey, Georgia	1,346
Oconee River at Dublin, Georgia	4,182
Octoraro Creek at mouth, Rowlandsville, Maryland	217
Ogden River at Powder Mills, near Ogden, Utah	360
Oldfield Creek (tributary of New River) near mouth, North Carolina	13
Olentangy River at Galion, Ohio	29
Olentangy River at mouth, Columbus, Ohio	532
Oneida Creek (tributary of Oneida River) at Kenwood, New York	59
Oneida Creek (tributary of Oneida River) at mouth, New York	149
Oneida Lake at outlet, New York	1,300
Oneida River at mouth, New York	1,402
Oostanaula River at Resaca, Georgia	1,614
Oostanaula River at mouth, Rome, Georgia	2,152
Oriskany Creek at State dam, Oriskany, New York	144
Oriskany Creek at Coleman, New York	141
Oriskany Creek at mouth, New York	146
Oswego River below Three River Point, New York	167
Oswego River below junction of Seneca and Oneida rivers, New York	4,868
Oswego River at Fulton, New York	4,916
Oswego River at gaging station, New York	4,990
Oswego River at high dam near Oswego, New York	5,000
Oswego River at mouth, New York	5,002
Otego Creek (tributary of Susquehanna River) at mouth, New York	106
Otisco Lake at outlet, New York	41
Otselic River (tributary of Susquehanna River) at mouth, New York	259
Otter Creek (tributary of Black River) at mouth, New York	60
Onondaga Lake at outlet, New York	267
Oquago Creek, New York. *See* Coquago Creek.	
Owasco Outlet at Owasco Inlet, New York	120
Owasco Outlet at foot of Owasco Lake, New York	208
Owasco Outlet at Auburn, New York	212
Owasco Outlet at mouth, New York	230
Owego Creek (tributary of Susquehanna River) at mouth, New York	391
Owyhee River at Owyhee, near Ontario, Oregon	9,875
Paddys Creek (tributary of Catawba River) near mouth, North Carolina	13
Palouse River at Hooper, Washington	2,210
Palouse River below mouth of Cow Creek, Washington	2,460
Passadumkeag River at mouth, Maine	400
Patapsco River, South Branch, Maryland	84
Patapsco River, North Branch, Maryland	166
Patapsco River at Woodstock, Maryland	251
Patapsco River above Patapsco Station, Maryland	361
Patuxent River above mouth of Little Patuxent River, Maryland	194
Patuxent River at Laurel, Maryland	137
Patuxent River below junction of West Branch	515

		Square miles.
Pawpaw Creek (tributary of French Broad River) 1 mile above mouth, North Carolina		4
Pawpaw River (tributary of St. Joseph River) at mouth, Michigan		429
Payette River at Payette, Idaho		3,565
Peach Bottom Creek (tributary of New River) above mouth, Virginia		28
Penobscot River opposite extremity of Moosehead Lake, below mouth of Nulhedus Creek, Maine		600
Penobscot River at entrance to Chesuncook Lake, Maine		870
Penobscot River at outlet of Chesuncook Lake, Maine		1,440
Penobscot River at outlet of Twin Lakes, Maine		1,990
Penobscot River below mouth of East Branch, Maine		3,160
Penobscot River below mouth of Piscataquis River, Maine		6,590
Penobscot River at Oldtown, Maine		7,240
Penobscot River at Bangor, Maine		7,910
Penobscot River at mouth, Maine		8,550
Penobscot River, East Branch, at mouth, Maine		1,170
Pepacton River (tributary of Delaware River) at mouth, New York		919
Perkiomen Creek at Frederick, Pennsylvania		152
Phillips Creek (tributary of Genesee River) at mouth, New York		32
Piedra River at Arboles, Colorado		670
Pigeon Creek (tributary of Nolichucky River) at mouth, North Carolina		5
Pigeon Roost Creek (tributary of Nolichucky River) at mouth, North Carolina		11
Pigeon River at Newport, Tennessee		655
Piscataquis River at Dover, Maine		380
Piscataquis River below outlet of Sebec Lake, Maine		750
Piscataquis River at mouth, Maine		1,500
Platte River at North Platte, Nebraska:		
North Platte River	28,517	
South Platte River	23,294	
		51,811
Platte River at Columbus, Nebraska		56,867
Platte River, North and South, in Colorado	22,230	
Platte River, North and South, in Nebraska	10,850	
Platte River, North and South, in Wyoming	24,240	
		57,320
Platte River, South Fork, at Lake Cheesman, Colorado		1,677
Plum Tree Creek (tributary of Nolichucky River) at mouth, North Carolina		6
Pomer Creek (tributary of Holston River) at mouth, Virginia		13
Portage River (tributary of St. Joseph River) at mouth, Michigan		178
Portneuf River at McCammon, Idaho		500
Portneuf River at Pocatello, Idaho		1,130
Potomac River, North Branch, above Bloomington, Maryland		293
Potomac River, North Branch, at Piedmont, West Virginia, including Savage Creek (111)		409
Potomac River, North Branch, at Cumberland, Maryland, including New Creek at mouth, Keyser, West Virginia (56)		891
Potomac River, North Branch, at junction with South Branch, including Patterson Creek at Burlington, below Mill Creek (155), and at mouth (279)		1,365
Potomac River, South Branch, at junction with North Fork, including 188 square miles at Franklin		318

	Square miles.
Potomac River, South Branch, including North Fork below Seneca Creek (240) and at mouth (322)	640
Potomac River, South Branch, at Moorefield, West Virginia, including Mill Creek at mouth (101)	897
Potomac River, South Branch, below Moorefield, including South Fork at Fort Seybert, West Virginia (155), and at mouth, at Moorefield (301)	1,198
Potomac River, South Branch, at Romney, West Virginia	1,407
Potomac River, South Branch, at U. S. G. S. gaging station at railway bridge between Romney and Springfield, West Virginia	1,443
Potomac River, South Branch, at mouth, West Virginia	1,487
Potomac River at new gaging station, West Virginia	1,440
Potomac River at junction of North and South branches, West Virginia	2,852
Potomac River above Great Cacapon River, including Little Cacapon River, West Virginia (117)	3,388
Potomac River below Great Cacapon River, including Great Cacapon above North River (404) and at mouth, West Virginia (671)	4,059
Potomac River at Hancock, West Virginia	4,099
Potomac River at Williamsport, Maryland, including Warmspring Creek at mouth (16), Conoloway Creek (125), Sleepy Creek (146), Licking Creek (195), Back Creek (288), and Conocockeague Creek (579)	5,556
Potomac River at Harpers Ferry, West Virginia, including Opequan Creek (335) and Antietam Creek (305)	6,354
Potomac River below Harpers Ferry, West Virginia, including Shenandoah River (3,009)	9,363
Potomac River at Weverton, Maryland	9,397
Potomac River at Point of Rocks, Maryland	9,654
Potomac River at Edwards Ferry below Goose Creek, including Monocacy River at mouth (941) and Goose Creek (384)	11,100
Potomac River at Great Falls, Maryland, including Seneca Creek (132)	11,427
Potomac River at Chain Bridge, District of Columbia	11,545
Prairie River (tributary of St. Joseph River) at mouth, Michigan	164
Prather Creek (tributary of New River) at ford one-half mile below Scottville, North Carolina	9
Price Creek (tributary of Nolichucky River) at mouth, North Carolina	18
Prosser Creek at Boca, California	55
Provo River at Provo, Utah	640
Purgatory Creek at Trinidad, Colorado	742
Purgatory Creek at Las Animas, Colorado	3,040
Queen Creek at Whitlow's ranch, Arizona	143
Rack River at mouth, Michigan	213
Reedy Patch Creek (tributary of Broad River) at mouth, North Carolina	12
Reams Creek (tributary of French Broad River) at mouth, North Carolina	36
Red Bank Creek (tributary of Allegheny River) at Brookville, Pennsylvania	400
Red Cedar River at Agricultural College, Michigan	358
Red Cedar River at mouth, Michigan	472
Reddie Creek (tributary of Yadkin River) at North Wilkesboro, North Carolina	95
Red River in Texas	15,800
Red Rock Creek at Redrock, Montana	1,330
Republican River, North Fork, at Haigler, Nebraska	1,390
Republican River at Superior, Nebraska	22,347

		Square miles.
Republican River at Junction, Kansas		25,837
Republican River in Colorado	7,926	
Republican River in Nebraska	10,415	
Republican River in Kansas	7,496	
		25,837
Rice Creek at Marshall, Michigan, 1 mile above mouth		99
Rio Grande at Del Norte, Colorado		1,400
Rio Grande at Cenicero, Colorado		7,695
Rio Grande at Embudo, New Mexico		10,090
Rio Grande at Rio Grande, New Mexico		14,050
Rio Grande at San Marcial, New Mexico		28,067
Rio Grande at El Paso, Texas		30,000
Rio Grande in Colorado	7,493	
Rio Grande in New Mexico	72,380	
Rio Grande in Texas	80,550	
		160,423
Roan Creek (tributary of Watauga River) at Butler, Tennessee		164
Roanoke River at Roanoke, Virginia		388
Roanoke River at Clarksville, Virginia		7,344
Roanoke River at Neal, North Carolina		8,717
Roaring Creek (tributary of Nolichucky River) at mouth, North Carolina		10
Roaring River (tributary of Yadkin River) at Roaring River, North Carolina		137
Rock Creek (tributary of Nolichucky River) at ford on Micaville-Marion road, North Carolina		2
Rock Creek at Battle Mountain, Nevada		725
Rock Creek at Zoological Park, District of Columbia		83
Rush Creek (tributary of Genesee River) at mouth, New York		35
Rush Creek (tributary of Holston River) at mouth, Virginia		8
Rockhouse Creek (tributary of Watauga River) at mouth, North Carolina		2
Saco River at Fryeburg, Maine		439
Saco River at Great Falls at Hiram, Maine		856
Saco River at Highland Rips, Maine		1,366
Saco River at Bonny Eagle Falls, Maine		1,578
Sacramento River at Jellys Ferry, California		9,134
Sacramento River above Redbluff, California		9,356
Sacramento and San Joaquin rivers in California	63,020	
Sacramento River in Oregon	655	
		63,675
Sacandaga River, South Branch, at mouth, New York		240
Sacandaga River, East Branch, at mouth, New York		124
Sacandaga River, Middle Branch, at mouth, New York		115
Sacandaga River below Stony Creek, New York		223
Sacandaga River at mouth, New York		1,056
St. Clair Creek (tributary of Holston River) at mouth, Virginia		8
St. Croix River, West Branch, at Princeton dam, Maine		540
St. Croix River, West Branch, at confluence with main river, Maine		750
St. Croix River at Grand (Schoodic) Lake, Maine		420
St. Croix River at Little Falls, Maine		500
St. Croix River above mouth of West Branch, Maine		650
St. Croix River below mouth of West Branch, Maine		1,400
St. Croix River at Spragues Falls, Maine		1,450
St. Croix River at lower dam at Calais, Maine		1,530
St. Croix River at mouth, eastern border of Calais, Maine		1,630

		Square miles.
St. Joseph River above Three Rivers, Michigan		863
St. Joseph River below Three Rivers, Michigan		1,417
St. Joseph River above Niles, Michigan		3,616
St. Joseph River below mouth of Dowagiac River, Michigan		3,898
St. Joseph River above mouth of Pawpaw River, Michigan		4,157
St. Joseph River below mouth of Pawpaw River, Michigan		4,586
St. Louis River above Cloquet, Minnesota		3,272
St. Vrain Creek near Lyons, Colorado		209
Salina Creek at Salina, Utah		255
Salinas River at Salinas, California		4,940
Saline River at Beverly, Kansas		2,730
Saline River at mouth, Kansas		3,311
Salmon Creek (tributary of Cayuga Lake) at mouth, New York		90
Salmon River 1 mile above falls, New York		191
Salmon River at bridge station, New York		264
Salt Lake, Utah. *See* Great Salt Lake.		
Salt River below Tonto Creek, Arizona		5,756
Salt River in canyon 20 miles above Verde River, Arizona		5,880
Salt River at Arizona dam, Arizona		12,260
Salt River at McDowell, Arizona, above Verde River		6,260
Saluda River at Waterloo, South Carolina		1,056
Sandy Mush Creek (tributary of French Broad River) at mouth, North Carolina		81
San Emidio Creek, California		54
San Gabriel River at canyon above Azusa, California		220
San Gabriel River above narrows at Paso de Bartolo Rancho, California		567
San Joaquin River at Herndon, California		1,637
San Juan River at Arboles, Colorado		1,320
San Miguel River at Fallscreek, Colorado		327
San Pedro River at Dudleyville, Arizona		2,870
San Pedro River in Arizona	3,336	
San Pedro River in Mexico	120	
		3,456
San Pitch River at Gunnison, Utah		836
Sandy River at Farmington, Maine		340
Sandy River at mouth, Maine		650
Santa Ana River at Warmsprings, California		188
Saquoit Creek at New York Mills, New York		52
Saquoit Creek at mouth, New York		67
Savannah River at Calhoun Falls, Georgia		2,712
Savannah River at Augusta, Georgia		7,294
Schoharie Creek at Gilboa, New York		308
Schoharie Creek at Central Bridge, New York		684
Schoharie Creek at State dam at Fort Hunter, New York		947
Schoharie Creek at Schoharie Falls, New York		930
Schoharie Creek at Mill Point, New York		934
Schroon River at foot of Schroon Lake, New York		479
Schroon River at Tumblehead Falls, New York		502
Schroon River at Warrensburg, New York, gaging station		563
Schroon River at mouth, New York		550
Scioto River at Kenton, Ohio		153
Scioto River at Columbus, Ohio		1,070
Scioto River at Shadeville, Ohio, including Olentangy River (523)		1,670
Scioto River at mouth, Ohio		6,432

		Square miles.
Sebago Lake near outlet, Maine		470
Sebasticook River at mouth, Maine		1,060
Seneca Lake at outlet, New York		707
Seneca River at foot of Seneca Lake, New York		707
Seneca River at Waterloo, New York		745
Seneca River at Seneca Falls, New York		771
Seneca River at entrance to Cayuga Lake, New York		780
Seneca River below Cayuga Lake, New York		1,593
Seneca River at Montezuma, New York		2,472
Seneca River at Baldwinsville, New York		3,103
Seneca River at junction with Oneida River, New York		3,433
Sevier River at Gunnison, Utah		3,986
Sevier River at Leamington, Utah		5,595
Shenandoah River, North Fork, at Brocks Gap, Virginia		215
Shenandoah River, North Fork, at Mount Jackson, Virginia		511
Shenandoah River, North Fork, at Riverton, Virginia		1,037
Shenandoah River, South Fork, at Port Republic, Virginia, including Middle River at junction with North River (363), North River at junction with Middle River (418), North River at junction with South River (804), South River at junction with North River (246)		1,050
Shenandoah River, South Branch, at Shenandoah, Virginia		1,288
Shenandoah River, South Branch, at Overall, Virginia		1,491
Shenandoah River, South Branch, at mouth at Riverton, Virginia		1,587
Shenandoah River, South Branch, at Front Royal, Virginia, gaging station		1,569
Shenandoah River at Riverton, Virginia, including North Fork (1,037) and South Fork (1,587)		2,624
Shenandoah River at Millville, West Virginia		2,995
Shenandoah River at mouth, Harpers Ferry, West Virginia		3,009
Shoshone River, South Fork, at Marquette, Wyoming		500
Shoshone River at Corbett, Wyoming		1,718
Shoshone River at Lovell, Wyoming		2,720
Shut-in Creek (tributary of French Broad River) at ford on Hot Springs-Point Rock road, North Carolina		9
Silver Creek (tributary of Catawba River) near mouth, North Carolina		62
Silver Lake (tributary of Genesee River) at mouth, New York		30
Sinking Creek, or Beidlemans Creek (tributary of Holston River) at mouth, Tennessee		25
Sinking Creek (tributary of Watauga River) at lower ford, Tennessee		12
Skaneateles Lake at outlet, New York		73
Smoky Hill River at Ellsworth, Kansas, including drainage in Colorado (1,533) and Kansas (6,447)		7,980
Smoky Hill River below Ellsworth, Kansas, exclusive of Saline and Solomon rivers		2,255
Smoky Hill River at mouth, Junction, Kansas		20,428
Snake River, North Fork, at Ferry, Idaho		931
Snake River at Idaho Falls, Idaho		10,100
Snake River at Montgomery Ferry, Idaho		22,600
Snake River in Idaho	73,500	
Snake River in Nevada	5,280	
Snake River in Oregon	17,950	
Snake River in Washington	6,682	
Snake River in Wyoming	5,268	
		108,680

	Square miles.
Soleduck River at Quillayute, Washington	272
Solomon River at Beloit, Kansas	5,539
Solomon River at Niles, Kansas	6,815
Solomon River at mouth, Kansas	6,882
South River at Port Republic, Virginia	1,050
South (of James) River at mouth, Virginia	116
South Boulder Creek at South Boulder Canyon, near Marshall, Colorado	125
South Branch or Fork of any river, *see* the river.	
South Indian Creek (tributary of Nolichucky River) at mouth, near Erwin, Tennessee	85
South Platte River at Lake Cheesman, Colorado, gaging station	1,677
South Platte River at Deansbury, Colorado	2,600
South Platte River at Platte Canyon, Colorado	2,620
South Platte River at Denver, Colorado, including Bear Creek at Morrison (170)	3,840
South Platte River at Greeley, Colorado, above mouth of Cache la Poudre River	7,110
South Platte River below Greeley, Colorado	9,575
South Platte River at Orchard, Colorado	12,260
South Platte River at mouth, North Platte, Nebraska	22,294
South Toe River (tributary of Nolichucky River) at ford on Micaville-Sprucepine road, North Carolina	59
South Toe River (tributary of Nolichucky River) 1 mile above mouth of Three Fork Creek, North Carolina	19
Spanish Fork in canyon near Spanish Fork, Utah	670
Spokane River at Spokane, Washington	4,005
Spring Creek (tributary of French Broad River) at Hot Springs, North Carolina	73
Spring Creek (tributary of Holston River) at mouth, Virginia	16
Squirrel Creek (tributary of Nolichucky River) at mouth, North Carolina	5
Staley Creek (tributary of Holston River) at Marion, Virginia	12
Stanislaus River at Oakdale, California	1,051
Staunton River at Clarksville, Virginia	3,546
Steamboat Creek at Steamboat Springs, Nevada	40
Stony Creek (tributary of Sacandaga River) at mouth, New York	212
Stony Creek (tributary of Watauga River) one-half mile above mouth, Tennessee	49
Strawberry Creek (tributary of Duchesne River) at mouth, Utah	1,166
Sugar River (tributary of Black River) at mouth, New York	66
Sun River at Augusta, Montana	1,175
Susquehanna River, West Branch, at Allenwood, Pennsylvania	6,538
Susquehanna River, West Branch, at mouth, Pennsylvania	7,027
Susquehanna River above mouth of Oak Creek, New York	97
Susquehanna River below mouth of Oak Creek, New York	212
Susquehanna River below mouth of Unadilla River, New York	1,638
Susquehanna River at Nineveh, New York	1,789
Susquehanna River at Susquehanna, New York	2,024
Susquehanna River at Birmingham, New York	2,279
Susquehanna River above mouth of Chemung River, New York	4,945
Susquehanna River at Pennsylvania-New York State line	6,267
Susquehanna River below mouth of Chemung River, Pennsylvania	7,463
Susquehanna River at Wilkesbarre, Pennsylvania	9,810
Susquehanna River at Danville, Pennsylvania	11,070
Susquehanna River above confluence with West Branch, Pennsylvania	11,142

	Square miles.
Susquehanna River at Harrisburg, Pennsylvania	24,030
Susquehanna River at mouth, Pennsylvania	27,405
Swannanoa River, North Fork, at bridge 3 miles above Swannanoa post-office, North Carolina	30
Swannanoa River (tributary of French Broad River) at Biltmore, North Carolina	124
Sweetwater River at mouth, Wyoming	2,929
Sweetwater River at Sweetwater dam, California	186
Tahoe Lake at outlet, California (water surface 193 square miles)	502
Talladega Creek at Nottingham, Alabama	156
Tallapoosa River at Sturdevant, Alabama	2,500
Tallapoosa River at Susanna, Alabama	2,610
Tallapoosa River at Milstead, Alabama	3,840
Tallulah River at Tallulah Falls, Georgia	191
Tar River at Tarboro, North Carolina	2,290
Tanghanic Creek (tributary of Cayuga Lake) at mouth, New York	60
Tehachapi Creek (tributary of Caliente Creek), California	108
Tejon House Creek at Tejon ranch, California	17
Tennessee Fork of Arkansas River near Leadville, Colorado	44
Tennessee River at Chattanooga, Tennessee	21,418
Tennessee River at confluence of Broad and Holston rivers, at Knoxville, Tennessee	8,924
Tennessee River at Knoxville, Tennessee	8,990
Teton River at Wilford, Idaho	967
Thomas Creek (tributary of Holston River) at mouth, Tennessee	11
Thornapple River (tributary of Grand River) at mouth, Michigan	824
Threetop Creek (tributary of New River) on footbridge at Creston, North Carolina	24
Thunder Bay River, North Branch, above mouth, Michigan	199
Thunder Bay River, South Branch, above mouth, Michigan	454
Thunder Bay River above mouth of North Branch, Michigan	580
Thunder Bay River above mouth of South Branch, Michigan	789
Thunder Bay River at Alpena, Michigan	1,267
Tioga River above mouth of Canisteo River, New York	750
Tioga River (tributary of Susquehanna River) at mouth, New York	1,530
Tioughnioga River, West Branch, at mouth, New York	103
Tioughnioga River, East Branch, at mouth, New York	164
Tioughnioga River (tributary of Susquehanna River) above mouth of Atselic River, New York	428
Tioughnioga River (tributary of Susquehanna River) at mouth, New York	735
Tongue River at Miles City, Montana	3,875
Town Creek (tributary of Watauga River) at Shoun crossroads, Tennessee	19
Three Fork Creek (tributary of Nolichucky River) ¼ mile above mouth, North Carolina	5
Thompson Creek near Loveland, Colorado	305
Toccoa River at Blueridge, Georgia	231
Toe River (tributary of Nolichucky River) at Huntdale, North Carolina	438
Tohickon Creek at Point Pleasant, Pennsylvania	1,022
Towaliga River at mouth, Juliette, Georgia	350
Truckee River, Upper, at inlet to Lake Tahoe, California	59
Truckee River at Tahoe, California	502
Truckee River at California-Nevada State line	955
Truckee River at mouth of Little Truckee River at Boca, California	869

	Square miles.
Truckee River near Essex, Nevada	991
Truckee River near Laughtons, Nevada	1,014
Truckee River at Vista, Nevada	1,435
Tuckasegee River 3 miles above Bryson, North Carolina	609
Tuckasegee River at Bryson, North Carolina	662
Tucker Creek (tributary of French Broad River) 200 yards above mouth, North Carolina	6
Tugaloo River at Madison, South Carolina	593
Tule River above Portersville, California	437
Turkey Creek (tributary of French Broad River) at Blackwell Springs, North Carolina	28
Turkey Cove Creek (tributary of Catawba River) ¼ mile above mouth, North Carolina	31
Tuscarora Creek (tributary of Susquehanna River) at mouth, New York	120
Tuolumne River at Lagrange, California	1,501
Tuolumne River at Modesto, California	1,635
Uinta River at the canyon, Utah	218
Uinta River at Fort Duchesne, Utah	672
Uinta River at Ouray School, Utah	967
Umatilla River at Gibbon, Oregon	353
Umatilla River at Pendleton, Oregon	640
Umbagog Outlet immediately above junction with Magalloway River, Maine	760
Unadilla River (tributary of Susquehanna River) at mouth, New York	561
Uncompahgre River at Fort Crawford, Colorado	497
Uncompahgre River at Montrose, Colorado	565
Upper Creek (tributary of Catawba River) near mouth, North Carolina	85
Upper Black Creek (tributary of Genesee River) at mouth, New York	39
Upper Laurel Creek (tributary of Watauga River) at mouth, North Carolina	7
Upper Truckee River at inlet to Lake Tahoe, California	59
Valley River at Philippi, West Virginia	620
Van Campens Creek (tributary of Genesee River) at mouth, New York	56
Vandemarck Creek (tributary of Genesee River) at mouth, New York	22
Verde River near Fort McDowell, Arizona	6,000
Verde River 1 mile above Salt River, Arizona	6,000
Verdigris River at McTaggart's mills, Kansas	3,067
Walker Creek (tributary of Holston River) at mouth, Virginia	13
Wallawalla River at Whitman, Washington	310
Wallkill River at New Jersey-New York State line	210
Walnut Creek (tributary of French Broad River) at mouth, North Carolina	17
Watauga River at Elizabethton, Tennessee	408
Watauga River at Butler, Tennessee	261
Watauga River at Watauga Falls, North Carolina	96
Watauga River 1 mile above Shull's mill, North Carolina	12
Watauga River, Boone Fork, at Shull's mill, North Carolina	9
Weber River at Uinta, Utah	1,600
Weiser River at Weiser, Idaho	1,670
Wenache River 7 miles above Wenache, Washington	1,527
West Branch of any river, *see* the river.	
West Canada Creek at Twin Rock Bridge, New York	252
West Canada Creek at Trenton Falls, New York	375
West Canada Creek at Middleville, New York, gaging station	518

		Square miles.
West Canada Creek at Herkimer, New York		548
West Canada Creek at mouth, New York		569
West Fork of any river, *see* the river.		
West Gallatin River at Williams's ranch, Montana		860
White Creek (tributary of Genesee River) at mouth, New York		16
Whiteoak Creek (tributary of South Fork of Toe River) at mouth, North Carolina		3
Whiteoak Creek (tributary of North Fork of Toe River) at mouth, North Carolina		4
Whiterocks River (tributary of Duchesne River) at canyon, Utah		114
White River at city of Whiteriver, Colorado		1,773
White River at Crawford, Nebraska		270
White River at Buckley, Washington		450
Whitetop Creek (tributary of Holston River) at mouth, Virginia		66
Wilsons Creek (tributary of Catawba River) at mouth, North Carolina		70
Wilsons Creek (tributary of New River) 2 miles above mouth, Virginia		37
Wiscoy Creek (tributary of Genesee River) at mouth, New York		109
Wissahickon Creek near Philadelphia, Pennsylvania		65
Wolf Creek (tributary of Holston River) at mouth, Virginia		28
Wolf Creek (tributary of Genesee River) at mouth, New York		19
Wood River at Hailey, Idaho		906
Wood River at Toponis, Idaho		2,190
Yadkin River at second ford below Patterson's mill, North Carolina		86
Yadkin River at Wilkesboro, North Carolina		272
Yadkin River at Siloam, North Carolina		1,219
Yadkin River at Salisbury, or Holtsburg, North Carolina		3,399
Yadkin River at Norwood, North Carolina		4,614
Yakima River at Union Gap, Washington		3,300
Yakima River at Selah, Washington		1,960
Yakima River at Kiona, Washington		5,230
Yellow River at Almon, Georgia		379
Yellowstone River at Horr, Montana		2,635
Yellowstone River at Livingston, Montana		3,580
Yellowstone River in Montana	36,312	
Yellowstone River in North Dakota	250	
Yellowstone River in Wyoming	33,121	
		69,683
Youghiogheny River at Friendsville, Maryland		295
Youghiogheny River at Confluence, Pennsylvania		782
Youghiogheny River at West Newton, Pennsylvania		1,552
Yuba River, Middle Fork, at Freeman's bridge, North San Juan, California		205
Yuba River, North Fork, at Yuba Power Company's dam, North San Juan, California		483
Yuba River at Parks Bar bridge, Smartville, California		1,211
Yukon River in Canada	150,768	
Yukon River in United States	180,144	
		330,912

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[The Water-Supply and Irrigation Papers are limited by law to 100 pages each. It was therefore necessary to divide the report on the operations at river stations for 1900 into six parts. Paper No. 47 contains pages 1 to 100; Paper No. 48, pages 101 to 196; Paper No. 49, pages 197 to 292; Paper No. 50, pages 293 to 388; Paper No. 51, pages 389 to 488; Paper No. 52, pages 489 to 575.]

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., April 12, 1901.

SIR: I have the honor to transmit herewith a manuscript by Prof. Israel C. Russell, of Ann Arbor, Michigan, relating to the geology and water resources of Nez Perce County, Idaho, for publication in the series of Water-Supply and Irrigation Papers. This is the result of the examination conducted during the field season of 1900. The facts obtained have considerable value, not only in the development of water, but also in obtaining a knowledge of the other resources of this important area. The details and descriptions have increased the length of the manuscript to such an extent that, in order to conform with the terms of the law restricting the pamphlets to 100 pages, it is necessary to divide the material into two portions, the first or preliminary part relating to the geology and physiography of the area, and the second part taking up the water supply and other economic features.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

GEOLOGY AND WATER RESOURCES OF NEZ PERCE COUNTY, IDAHO.

PART I.

By Israel C. Russell.

LOCATION AND GENERAL CHARACTER OF REGION.

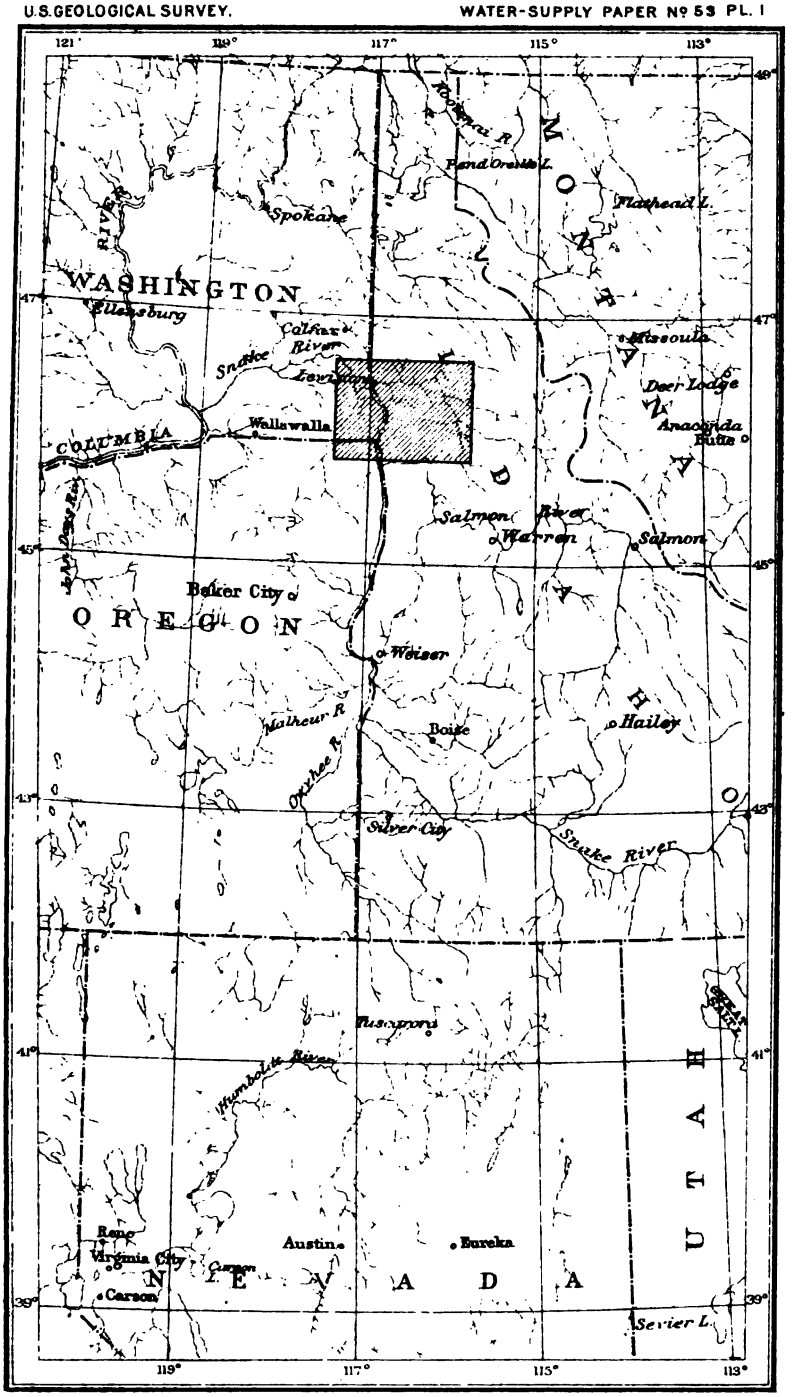
An investigation of the geology of Nez Perce County, Idaho, was made by the writer during the summer of 1900, with special reference to the possibilities of obtaining artesian water. Field work was carried on from July 4 to September 11, and examination was made of as much of the county and adjacent country as time permitted. In the absence of a satisfactory topographic map, however, only what is understood as reconnaissance work could be done, and without such a map it is also difficult to make a detailed and accurate presentation of the facts observed. For these reasons this paper should be considered as simply a report of progress, and not a complete and detailed geologic survey of the region visited and studied.

Nez Perce County, as is shown on Pl. I, is situated in western Idaho. It is bordered on the west by portions of Washington and Oregon, and the dividing line between these two States if prolonged eastward would cross the county about 10 miles from its southern boundary. As will be seen on the accompanying geologic sketch map (Pl. II), the western border of the county, to within about 4 miles of Lewiston, is marked by the middle line of Snake River. The other portions of the boundary need not be described, as they are indicated on the map referred to, but it will be convenient to bear in mind their relations to certain conspicuous topographic features. A part of the southern boundary is formed by Salmon River, and another part by Lawyers Creek, while the eastern boundary is determined by Clearwater River and the South Fork of the same stream. Each of the streams just mentioned, and also Snake River throughout the portion of its course shown on Pl. II, flows in a canyon 2,000 or more feet deep, so that

throughout much of its course the boundary of the county coincides with strongly pronounced features in the relief of the land.

The approximate area of the county is 1,335 square miles—somewhat larger than that of the State of Rhode Island. It is, however, one of the smaller of the twenty-one counties into which Idaho is divided. The main portion of the county lies between latitude 46° and 46° 35′ N., and between longitude 116° and 117° W. The county seat is Lewiston, which has a population of 2,425 and is situated on its western border, at the junction of Clearwater River with Snake River. Lewiston is connected with Clarkston, Washington, on the west side of Snake River, by a fine steel cantilever bridge. These two towns, frequently designated Lewiston-Clarkston, have a joint population of 4,000. There are also many villages and hamlets scattered throughout the county and over the adjacent country, more especially to the east and north, and isolated farmhouses and settlers' cabins are numerous. The population of the county is 13,748. Agriculture is the chief industry.

An examination of any recent map of the New Northwest will show that branches of the Northern Pacific Railroad and of the tracks of the Oregon Railway and Navigation Company extend into Nez Perce County and the country adjacent, and terminate without making through connections. These branches of two great trunk railroad systems suggest at once that the newly settled region which they invade has something that invites capital, and it will be found that the attraction which has drawn the steel bands through profound canyons, across broad plateaus, and over rugged mountains is mainly wheat. No doubt it will be a surprise to many of my readers to learn that the eastern portions of Washington and Oregon, with an adjacent strip of country in Idaho, produce annually from 50,000,000 to 60,000,000 bushels of wheat, as well as considerable quantities of other grain. This great and rapidly growing industry is based on the remarkable fertility of the soil and the favorable climatic conditions. The fine, dark, rich soil, as will be shown later, has resulted from the disintegration and decay of certain widely spread volcanic rocks, and is of almost unrivaled fertility. The climate, although in many respects favorable to agricultural pursuits, is not all that might be desired. The seasons are two in number, winter and summer; or, to use more descriptive terms, a humid season and a dry season. The winters, more particularly in the valleys and canyons and on the lower plateaus, are wet. Snow seldom lies on the ground for more than a few days at a time, but damp, chilly weather is prevalent, and practically all the rain of the year falls during that time. It is stated that the only "zero weather" known at Lewiston within the last ten years or longer occurred in February, 1899, when the temperature during one night fell to 7½° below zero; the next coldest period was in January, 1899, when the thermometer registered 12° above zero. On the higher plateaus and mountains, or, in general, at



MAP SHOWING POSITION OF NEZ PERCE REGION

Scale

100 50 25 0 50 100 200 MILES

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an elevation of 2,000 or more feet above Lewiston, equivalent to an elevation of 3,000 feet above the sea, the climate throughout the year is cooler and more humid than at lower altitudes, and in winter the cold is frequently severe and the snow deep. In the Bitterroot Mountains, to the east of Nez Perce County, the marks made on the trees in winter, known as "snow-shoe blazes," are from 15 to 20 feet above the ground, and show that the snow accumulates to great depths. These mountains are densely forest covered, are uninhabited, and judging from the nature of the vegetation the climate is cold and the precipitation abundant. Between the two extremes in elevation, namely, the canyons and lower plateaus and the truly mountainous portions of the country, there are certain broad plateaus, such as the one to the north of Clearwater River, termed in this paper the Uniontown Plateau, and the Camas and Kamiah prairies, which have surface elevations of about 3,000 feet and are intermediate in climatic conditions between the extremes just referred to. The winters, although colder than at lower elevations, are not severe; snow remains on the ground several weeks, but seldom affords good sleighing, and the rainfall is frequently heavy. During the long, clear summers the days are hot, but the nights are always cool.

The most populous portions of the region are thus without the cold, clear winter weather, with the land snow covered, which forms so characteristic a feature of the States in the same latitude on the eastern side of the continent. On the contrary, the open winters of western Idaho and of adjacent portions of Washington and Oregon are characterized by frequent changes from frost to thaw. The air is frequently damp and chilly, and much of the time the roads are all but impassable, on account of the deep mud. The summers are long, and in the canyons and on the lower plateaus the heat at times is intense, the thermometer frequently registering 100° F. or more in the shade. Owing to the dryness of the air, however, this extreme heat is less oppressive than a much lower temperature would be in more humid lands. During the summer hot winds, the equivalent of the warm chinook winds of winter, also occasionally occur, which, particularly on the lower plateaus, sometimes wither the green grain in a few hours and cause great losses. During the heat of the summer the soil is dry, frequently parched, and the dust on the roads lies several inches deep, being often carried in the air in dense clouds.

The rainfall at Lewiston, situated in the lowest and driest portion of the Nez Perce region, is usually from 14 to 16 inches a year. Of this meager amount the larger portion comes between the first of November and the end of March. With increase in elevation there is an increase in precipitation, but in the absence of definite observations the annual rainfall on the higher plateaus can only be judged from the nature of the vegetation and the success with which various crops are

cultivated. On the Uniontown Plateau, where the elevation is about 3,000 feet, the annual precipitation is said to be in the neighborhood of 25 inches. In its original state this broad plateau was without trees, but was covered with a luxuriant growth of grasses and flowering annuals, which made it a beautiful prairie. The broad Camas and Kamiah prairies also were treeless, and may be considered to have about the same rainfall and other climatic features that characterize the Uniontown Plateau. At higher elevations, beginning, in general, at about 3,500 feet, forests appear, and give evidence of more abundant precipitation.

In the lower and drier portions of the county, particularly in the canyons of Snake and Clearwater rivers and on the adjacent plateaus, irrigation is necessary for all forms of agriculture except where the land is so low that it is subirrigated naturally from the streams. On the plateaus, 1,500 or more feet above the sea, wheat, oats, barley, flax, etc., are grown without water other than that absorbed and retained by the fine porous soil, and yield surprisingly abundant returns; but orchards, except under unusually favorable local conditions, require irrigation. On the higher plateaus and in the mountains, although the rainfall is sufficient for growing fruit, the temperature conditions are unfavorable except for berries and, possibly, apples. In the valleys and canyons, particularly those of Snake, Salmon, and Clearwater rivers, where suitable land can be had and where water for irrigation is also available, peaches, pears, plums, prunes, cherries, grapes, berries, and garden vegetables, all of excellent quality, are produced in great abundance.

With reference to native vegetation, the Nez Perce region may be divided into two portions, namely, prairies and forests. Before being plowed, the plateaus at elevations of 3,500 feet or less were clothed with bunch grass and a great variety of flowering annuals. With these natural meadows are to be classed also the precipitous border of most of the canyons, which are, for the most part, still in their natural state, except that they have been utilized for stock ranges and are still clothed with bunch grass. In early spring their rugged slopes are many tints of green, but as the heat of summer increases the grasses wither and become yellow. In late summer the entire landscape, from any commanding eminence rising above the plateaus, is various shades of yellow, for then the grain fields have changed to nearly the same color as the grass-covered canyon walls, the only exception to the prevailing old-gold color being furnished by the rich brown of the crumbling rocks in the canyon walls, the less prevalent black of the but slightly weathered basaltic lava, and rectangular areas of deep black, as it appears by contrast, which mark the locations of fallow lands among the grain fields.

While Nez Perce County and much of the adjacent country is highly

favored in many ways by soil and climatic conditions, there is in general a scarcity of water available for town supply, irrigation, and even for household purposes. While the streams are numerous, and several of them are of large size, they are, for the most part, in deep canyons, and are practically unavailable for irrigation or other economic uses. In certain instances, however, the water of streams has been diverted and is being used for irrigation, but the areas thus brought under cultivation are small in comparison with the total extent of rich agricultural land which needs water at certain seasons. The further utilization of the stream is limited by the great cost of constructing storage reservoirs, dams, and ditches, and by the conflicting interests involved. For these reasons attention has been directed to possible subterranean sources of water supply, and a number of wells have been drilled, one of which yields a good surface flow. It was with the hope that if the geologic conditions were understood the present scant water supply might be increased, not only by obtaining artesian water but by increasing the flow of springs, that the studies described in the following pages were undertaken.

GEOLOGY.

The rocks in the Nez Perce region form two sharply defined groups. The older group consists of a large variety of rocks of both igneous and sedimentary origin, and includes also great areas of metamorphic rock the original nature of which has not in all cases been determined. The younger group consists principally of basalt, but includes layers of clay, sand, gravel, volcanic dust, and lapilli interbedded with it. The older group was greatly disturbed by folding and otherwise, and formed a land surface that was deeply denuded before the younger group, which in general has been but moderately deformed, was spread out upon it. Thus, geologically, the two groups are sharply defined. Their differences are also conspicuous from the viewpoint of the economist. The older group contains a variety of excellent building stones, in many places carries gold and ores of various metals, and when decomposed forms usually a light-colored soil, which is not fertile; while the younger group, furnishing only the black basalt and certain soft beds of loosely compacted volcanic dust which can be used for building purposes, is without native metals or ores, but contains lignite which may prove of value, and on decomposing furnishes a deep, rich, dark soil of marvelous fertility.

With reference to the possibilities of obtaining artesian water, only the younger group needs to be considered; and as the principal aim of the reconnaissance was to ascertain to what extent the geologic conditions favor an increase in the underground water supply, but little attention could be given, in the time available, to the study of the rocks of the older group.

PRE-TERTIARY TERRANES.

The older rock group just referred to is considered to be of pre-Tertiary age, partly because of its lithologic similarity to known terranes of older date than the Tertiary, but principally because certain limestones found in it carry obscure fossils which seem to indicate a Mesozoic age, and because the Columbia River lava, which overlies portions of it unconformably, is known, from the fossils contained in the sedimentary beds included in it, to have been outpoured during Tertiary time.

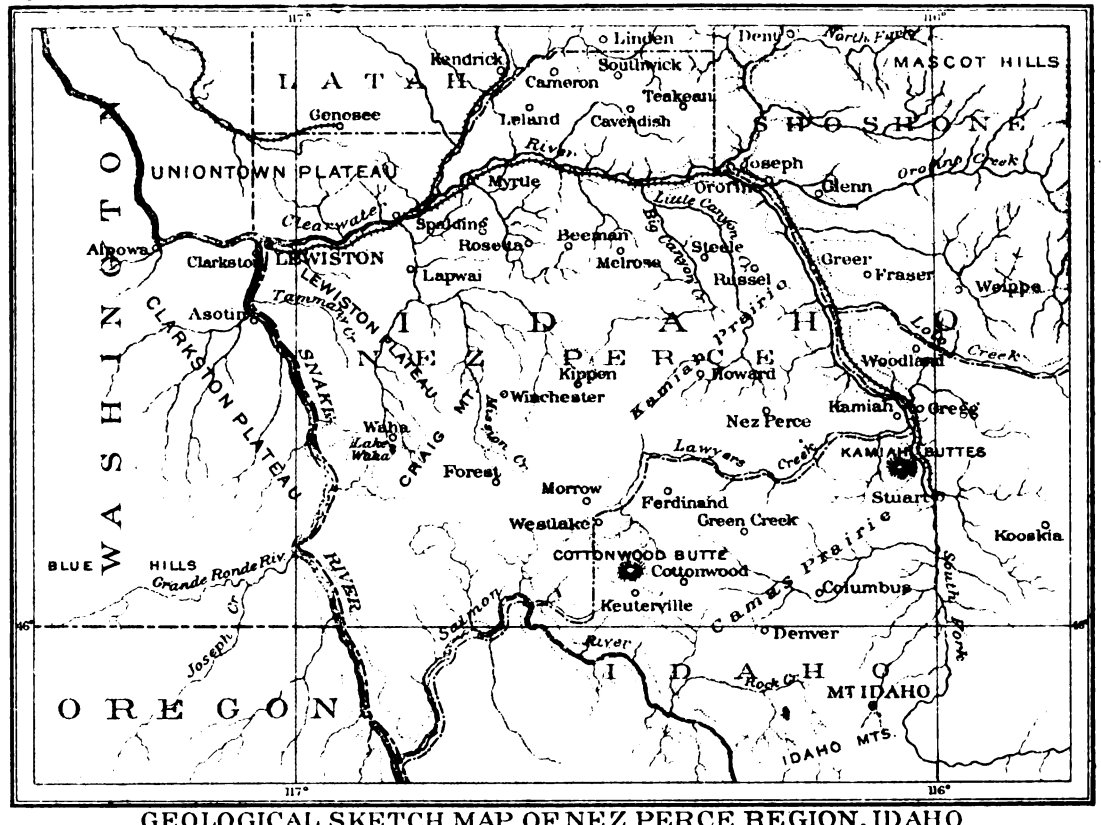
Rocks of older date than the Columbia River lava are now exposed at the surface. In some places these rocks were never covered by the lava, and in other places the lava beneath which they were formerly buried has been cut through or removed by stream erosion. The exposures of the former class, so far as the region shown in Pl. II is concerned, are in the foothills of the Bitterroot Mountains, and where Cottonwood Butte, Kamiah Buttes, and a few other island-like areas rise above the surface of the generally lava-covered country. The exposures of the older formations due to erosion occur where Snake, Salmon, and Clearwater rivers and some of their tributaries have cut through the lava and into the rocks beneath.

BITTERROOT MOUNTAINS.

Comparatively little information is available concerning the Bitterroot Mountains; but it is known that along their western border they are composed principally of gneiss and mica-schist, frequently rich in garnets, diorites, etc., with occasional porphyritic dikes and intrusions of rhyolite. The trend of the structural lines in the gneiss and schist and of the dikes is nearly north and south. About 20 miles east from the generalized western margin, as can be seen along the Lolo trail, a change occurs, and the great central portion of the mountains is seemingly composed throughout of a light-colored granite containing black mica and frequently large crystals of both white and pink feldspar. This granite is the country rock over a great area, extending far to the north of the Middle Fork of Clearwater River, and no doubt is a part of the extensive area of similar rock in the southern portion of the same mountains, mapped by W. Lindgren and shown by him to be intrusive and of post-Paleozoic age.[1] Lindgren makes the statement that this is the largest granite area in the United States, and gives a detailed description of the rock, accompanied by several chemical analyses.

A view of the Bitterroot Mountains from any commanding summit near their western border shows a multitude of peaks and sharp, serrate

[1] The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho, by Waldemar Lindgren: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 79-85.



GEOLOGICAL SKETCH MAP OF NEZ PERCE REGION, IDAHO.

Scale of miles

0 2 4 6 8 10 12 24 36

1901.

Columbia River lava (Tertiary)

Terranes older than the Columbia River lava

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crests rising to a general elevation of about 6,500 feet above the sea. (See Pl. III, *A*.) Between the elevations are deep canyons and valleys with flaring sides. The topography is characteristic of an old land surface, deeply denuded and now drained by a mature and well-developed system of waterways. Every view of the mountains impresses one with the vast amount of erosion that has occurred in the process of shaping the present peaks and removing the solid rocks which once occupied the valleys, and although this herculean task taxes the imagination to picture and understand, it is evidently small in comparison with the total amount of denudation required to lay bare the granite, which at the time of its intrusion must have been covered to a depth of thousands of feet by rocks which were hardened by its heat.

To the south of the Middle Fork of Clearwater River and in the west-central part of the Bitterroot Forest Reserve, is a range of prominent peaks termed The Crags, which rise from 3,000 to 4,000 feet above the general level of the rugged land surrounding them, and have patches of snow in their sheltered recesses late in the summer. Judging from their topography as seen at a distance, the depressions among the prominent peaks appear to have formerly been occupied by alpine glaciers. At least one of the secondary peaks, Rocky Crest, situated about 15 miles west of Bald Mountain and crossed by the Lolo trail, also bears evidence of former glaciation. On its eastern and northeastern sides there are three well-defined amphitheaters in the walls and over the bottoms of which are smoothed rock surfaces such as glaciers leave. These amphitheaters, eroded in the summit of a bold mountain, are about 500 feet deep, and on their lower margins open out into impressive stream-cut valleys. The glaciers which occupied them were in each instance about a mile in length and were isolated from one another. None of the adjacent mountains retain evidences of glaciation, although about 20 miles to the northeast of Rocky Crest there are prominent peaks which are similar in form to that mountain and which very likely once gave origin to small ice streams. This is the only evidence observed of the former presence of glaciers in the region represented on the map forming Pl. II, or over a large area to the east and west of that region. Seven Devils and Powder River mountains, from 40 to 50 miles south of the southern boundary of Nez Perce County, were in plain view from several points visited during the reconnaissance, and, judging from the topography and the fact that late in summer they are whitened with lingering snowbanks, it is to be presumed that they were formerly occupied by glaciers. This meager evidence, taken in connection with observations made by Eldridge[1] and Lindgren[2] in south-central Idaho, shows that throughout central and southern Idaho

[1] A geological reconnaissance across Idaho, by Geo. H. Eldridge: Sixteenth Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 223-224.

[2] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 100-101.

local glaciers only, of the alpine type, existed during the Glacial epoch, and that there was an absence of anything approaching a confluent ice sheet. The most instructive records made in this region during the time referred to are the stream-deposited gravels, some account of which will be given further on.

The Mascot Hills, indicated in part in the northeastern corner of the map forming Pl. II, are a typical portion of the foothills of the Bitterroot Mountains, adjacent to the eastern margin of the Columbia River lava, and may be taken as representative of the conditions that exist for a long distance to both the north and the south of them. These hills rise boldly to a height of about 1,100 feet above the lava plain skirting them on all sides except to the eastward, and form a prominent headland on the margin of the sea of molten rock which, as will be described further on, encroached on the western slope of the Bitterroot Mountains. The rocks forming the Mascot Hills consist, in large part at least, of gneiss and mica-schist traversed by quartz veins. As is an almost invariable rule along the western border of the Bitterroot Mountains, the trend of the rock structure is about north and south, and what appears to be the bedding of the gneiss and the lamination of the schist stands nearly vertical. A marked feature in the topography of the hills is their subdued and generally rounded profiles, indicative of long exposure to the atmosphere. Sustaining this conclusion is the fact that the rocks are deeply disintegrated and decomposed. At the extremity of a tunnel at the Mascot mine, 150 feet from its entrance and about 125 feet below the surface, the rock is so soft and so completely shattered that it can be removed with a pick, and even the quartz can be crumbled between the fingers. Although the rocks are evidently weathered to a great depth, nowhere about the hills is there evidence of the advanced degree of rock decay which gives origin to red soil. The characteristic topography and deep weathering referred to are among the numerous evidences that the older group of rocks under consideration has formed a land surface for a great length of time, and was deeply eroded before the coming to the surface of the younger group of rocks of the region, namely, the Columbia River lava.

From the summit of the Mascot Hills the relation of the Bitterroot Mountains to the vast lava plateau to the northward and westward is plainly revealed in the topography. To the north, and extending well to the northeast, there is a broad, level, densely forest-covered region across which the North Fork of Clearwater River has cut a steep-sided trench. Each branch of the river flows in a canyon, and what in distant views seems to be a level plateau is in reality deeply dissected. The summits of the canyon walls are formed of rim rocks of basalt, and the lower and usually bold slopes reveal the characteristic buttresses or terrace-like shoulders produced by the weathering of the more resistant rocks on which the basalt rests.

A. BITTERROOT MOUNTAINS, SHOWING MATURE TOPOGRAPHY.

B. CAMAS PRAIRIE; KAMIAH BUTTES IN THE DISTANCE.

The same plateau which has been deeply trenched by the North Fork and its numerous tributaries sweeps about the western base of the Mascot Hills and extends eastward up Orofino Creek nearly to Stuart. South of the canyon of Orofino Creek, with its precipitous walls of black basalt, the eye ranges over a long succession of rounded, forest-covered hills which project irregularly into a plateau to the westward, which is without forests and in summer is yellow, as far as the eye can reach, with grain fields. This vast cultivated tract, seemingly as level as a floor, is the Camas and Kamiah prairies. Although the plain is trenched by a number of narrow, steep-sided canyons, they are concealed from view, and the plateau appears as it did when the last of the lava sheets of which it is composed was poured out as molten rock. Rising from the sea-like expanse of the former grass-covered and flower-strewn prairie, and forming conspicuous objects in the far-reaching landscapes, are two elevations, known as Cottonwood Butte and Kamiah Buttes, which are easily recognized, even at a distance of many miles, as mountain peaks which stood as islands when the lava invasion occurred. A view from the summit of the Mascot Hills not only serves to reveal the general relation between the two groups of rocks of which the surrounding region is composed, but brings out the fact that although large portions of the plateau formed by the younger group still retain an essentially horizontal position, other portions have been tilted and otherwise deformed as well as trenched by stream channels. The evidence of extensive movements in the once horizontal lava sheets, however, will be discussed further on.

ISLAND-LIKE AREAS IN A SEA OF LAVA (STEPTOES).

The deep erosion of the pre-Tertiary land over which the Columbia River lava was poured out has already been referred to, but nowhere is it more clearly demonstrated than at Cottonwood Butte, which rises through the lava forming the Camas Prairie and in the adjacent portion of the canyon of Salmon River. This butte, which rises 1,100 or 1,200 feet above the generally level basaltic plateaus surrounding it, is composed of a variety of rocks belonging to the older group referred to. At its summit and on its western side the rocks are compact and massive, and consist largely of old lavas or intrusions which have been altered and somewhat metamorphosed. In its eastern portion reddish slate appears, the cleavage planes of which are nearly vertical, also ancient lavas and lapilli-like deposits that have been consolidated and greatly altered, probably by heated waters and pressure.[1]

[1] Rock samples collected on Cottonwood Butte have been examined by Waldemar Lindgren, who, from their macroscopic characteristics, made the following provisional determinations:

"A sample from west slope of the butte, metaandesite; from the top probably metabasalt or altered volcanic feldspar basalt; east slope, tuff or tuff-breccia, of old effusive rock, greenstone tuff, original character basaltic or andesitic; east end, clay slate (roofing slate), probably containing considerable admixed volcanic tuffaceous material."

These old rocks show that they were deeply eroded before the coming of the Columbia River lava, but were left, by the removal of the material which formerly surrounded them, as isolated mountain peaks. The time required for this topographic transformation was certainly long, although it can not be measured by years, but some idea concerning it may be had by comparing the tasks accomplished by erosion before and after the eruption of the Columbia River lava. The peak has stood fully exposed to storms and sunshine since the lava flowed about it, but evidently it has suffered only a moderate amount of denudation, although the neighboring canyon of Salmon River has been excavated in the lava and the underlying and more resistant rocks to a depth of fully 3,500 feet. The work of the river in shaping its magnificent canyon is small in comparison with the task which was accomplished previous to the coming of the lava in removing the material from about the hard rocks now forming the butte and leaving it a prominent mountain. The peak has suffered but little change during the time the adjacent canyon was being excavated, for the reason that it afforded but a small gathering ground for streams, and also because its slaty layers are on edge and permit the rain water falling on them to percolate through, thus robbing it of the power to corrade. The rocks of Cottonwood Butte are not only resistant to mechanical wear, changes of temperature, etc., but, equally important, they do not yield readily to chemical influences such as the solvent action of percolating water. Even at the surface they are hard, and show visible evidences of weathering to a depth of only a few feet, in some cases only a few inches. The soil on the butte is thin, and the rock exposures are abundant. The weathering which has produced the deep rich soil of the basaltic plateau has made but little progress on the more resistant rocks forming the much more ancient butte. Even when account is taken of the steep slopes of the butte and the fact that rock waste would be removed much more readily there than on the nearly flat prairie surface surrounding it, the evidence still favors the view that the butte has been changed but little in height or contour since the Columbia River lava was poured out. A view of the southern slope of the butte is shown in Pl. V, *A*. It is of interest to note also that the soil on the butte is different from that on the surrounding basaltic plateau, and was derived from the rocks on which it rests. Reference will be made further on to this and other kindred facts which show that the soil of the basaltic plateau was derived from the decay of the basalt itself, and was not brought from a distance through the agency of the wind.

As already stated, the slaty cleavage in the rocks forming Cottonwood Butte is nearly vertical. This has an important influence on the drainage, and accounts for the presence of the numerous springs of clear, cool water which occur there. One of these springs is in the

depression between the two summit peaks, and is supplied by the rain falling at higher levels. The northern side of the butte is forest covered, but its southern slope is mostly free from trees, and is clothed with bunch grass down to an horizon about 800 feet below the summit, where a pine forest begins which extends southward over the basaltic plateau.

No more charming camping place and no more attractive location for a summer resort can be found in the Nez Perce region than is afforded by this isolated mountain peak, from the summit of which so much of the earth's history can be read as from a printed page. From the summit of the butte one has not only a magnificent but a most instructive panorama spread out before him. In summer the air is nearly always cool and invigorating, and so clear that the distant mountains as well as the depths of the neighboring canyons seem near at hand, instead of many miles away. The clouds, which frequently form in vast, brilliantly illuminated banks about the higher peaks of the Bitterroot Mountains and drift over the broad wheat fields of the once monotonous prairie, mottling them with slowly moving shadows, serve to enhance the glory of the scene, and perhaps bring refreshing showers; violent storms are unknown in this region. In winter the ancient mountain peak is white with snow, and the cold frequently is intense. Looking southward from the topmost crag of the prominent butte on which the reader is invited to stand, in fancy, one sees at his feet the forest-covered plateau of Columbia River lava. Near at hand, rising from amid the dark pines, is the shining spire of a village church. A few miles beyond the dark plateau breaks off, as if an earthquake had shattered it, and one looks down into the purple depths of the vast chasm which Salmon River has eroded in order to carry its burden of sand and gravel to Snake River and then onward to the sea. The canyon is not a narrow gash in the rocks, with vertical walls, as the term may perhaps be thought to signify, but is a great excavation from 4 or 5 to 10 or more miles wide, with many serrate ridges and buttresses diversifying its precipitous sides. The upper portions of the canyon walls, sculptured into many forms by rain and rills, are of horizontal masses of dark rock (the edges of nearly level lava sheets), below which are more massive slopes showing where the underlying and more resistant rocks have been exposed. The course of the canyon can be traced for 50 or more miles—from far away to the southeast to where it makes a sharp bend, seemingly at one's feet, and thence southwestward to its junction with the larger and still more magnificent excavation of a similar nature in the depths of which Snake River is hidden. To the south of the canyon of Salmon River is a broad forest-clothed remnant of the original plateau, formed of lava, which is bordered on its farther side by the canyon of Snake River, there fully 4,000 feet deep. The upper portion of the vast south wall of Snake River Canyon is in view from the butte, and

when brilliantly illuminated by the sun, one can, at a distance of 25 miles, trace the outlines of the castle-like and cathedral-like forms which give diversity to its somber scenery. The brink of the distant canyon is marked by a dark line of pines and firs, and, like the layer of basalt beneath it, is the edge of a widely extended sheet—the great coniferous forest of eastern Oregon. Still farther away, but frequently sharply outlined against the southern sky, rise the angular peaks of the Seven Devils and Powder River mountains, their summits far above timber line and here and there flecked with snow which gleams like burnished silver in the intense light of the unclouded summer sun.

The view to the eastward embraces the broad undulating surface of the Camas and Kamiah prairies, which are checkered with rectangles of yellow grain fields and black fallow lands. The plain, several hundred square miles in area, is everywhere covered with a deep, rich soil, which has resulted from the decay of lava and is of wonderful fertility. Some suggestions are furnished of the deeply sunken stream channels which dissect this young land, but for the most part they are lost to view, and the great expanse, with its mild undulations, recalls the rolling prairie or the great plateaus to the east of the Rocky Mountains. The Camas and Kamiah prairies are bordered on the east by an irregular coast line of hills, beyond which rise the forest-covered peaks and ridges, with flowing outlines, which compose the nearer portion of the Bitterroot Mountains. The view to the westward is less extensive than in other directions, but it presents other instructive features. The generally level surfaces of the Camas and Kamiah prairies rise gently along their western margin and merge by insensible gradations into the long eastern slope of Craig Mountain. With increase in elevation there comes a change in the vegetation, and the open prairie country, with its grain fields, its scattered farmhouses, and its villages, gives place to a dark forest of pines and firs. The rocks which underlie the prairie have been bent upward and form a gently tilted plain, which breaks off abruptly on its farther (western) side, and there possesses some of the features of a mountain.

A few miles to the north and west of Cottonwood Butte there are low hills, composed of rocks which are older than the Columbia River lava, which, like the main butte, are islands in the lava plain. As sheet after sheet of molten rock was poured out and flowed over the land, it rose higher and higher on the sides of the once prominent mountains, but the inundation ceased before they were completely buried. Neighboring peaks of lesser height were no doubt covered, and ages hence will be revealed through the agency of erosion.

Another group of mountain summits left as islands in the lava sea occurs on the west side of the South Fork of Clearwater River, between the towns of Stuart and Kamiah, rising to elevations of 500 or 600 feet above the cooled and hardened surface. The Kamiah

Buttes, as they have been named, are between the canyon of the South Fork, which there is 1,800 feet deep, and the smaller but nearly as deeply cut canyon of Lawyers Creek. The nature of the rock forming the buttes is not definitely known, but what probably are portions of the same mass are exposed in the canyon of the South Fork; they are granite-like in character—more definitely, diorite. The buttes are without timber, and to some extent are now under cultivation. They consist of several rounded summits, and are to be classed with the foothills of the Bitterroot Mountains, now separated from them by about 6 miles of lava. A view of Camas Prairie, showing the Kamiah Buttes in the distance, is shown in Pl. III, *B*.

Another island-like area in the lava bed, of small size and rising only a few hundred feet above its surface, occurs 5 or 6 miles to the south of the Kamiah Buttes, on the brink of the canyon of the South Fork. Still another area, with a similar history, is situated farther north, on the west side of the same canyon, opposite Greer; from Kamiah Prairie it appears as a low hill with an undulating surface. Another and less conspicuous example occurs on the east brink of the canyon of Snake River, near Waha, but in this instance there is some question whether the elevation of old igneous rock now exposed was an island in the lava or was covered by it and has since been exposed by erosion.

Isolated mountain peaks rising through the Columbia River lava, of the general nature of those described, form conspicuous and instructive features in several portions of the vast region occupied by that formation, and are of such importance as to demand a family name by which to designate them. Steptoe Butte, near Garfield, Washington, which has been described in a previous paper,[1] is a typical example of these eminences, and its name may with propriety be adopted as a generic term by which to designate similar topographic forms. A steptoe, then, is an island-like area in a lava flow. Cottonwood Butte and the Kamiah Buttes are the largest steptoes in the Nez Perce region. These are far exceeded, however, by the Eagle Creek Range (known also as the Powder River Mountains) in Oregon, which, as stated by Lindgren,[2] consist of bare, rugged peaks that rise several thousand feet above the basaltic plateau surrounding them on all sides. This, the greatest steptoe known, has a diameter of 24 miles.

FORMATIONS BENEATH THE COLUMBIA RIVER LAVA.

As is indicated on the map forming Pl. II, the older group of rocks in the Nez Perce region is exposed in the deeper portions of several of the larger canyons that have been excavated in the Columbia River lava. The principal outcrops of this nature are along Clearwater

[1] A reconnoissance in southeastern Washington, by I. C. Russell: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4 (1897), pp. 38–40.

[2] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. III, p. 92.

River and several of its tributaries to the east of Peck; along Snake River above the mouth of Grande Ronde River; in the vicinity of Buffalo Rock; and on the sides of the canyon of Salmon River near its junction with Snake River and again at several localities from 20 to 30 miles above its mouth.

Near its mouth the North Fork of Clearwater River has cut through a thousand or more feet of basalt and deep into the underlying diorite and gneiss. The portion of the canyon sunk in these older rocks is steep-sided and all but impassable. Beginning about 6 miles above its mouth, however, the basalt comes down to the stream, and for 4 or 5 miles the canyon broadens so as to leave room for a few small farms on its western side, where it is about 2,000 feet deep. About a mile below the mouth of Elk Creek the older group of rocks appears again in the lower portion of the canyon wall and continues for at least 25 miles upstream, probably to the eastern edge of the basalt. Throughout this distance the rocks beneath the lava are mainly gneiss and mica-schist rich in garnets. In places the older terranes are traversed by light-colored porphyritic dikes, and in a few instances by dikes of dark rock apparently of the same nature as the lava which forms the upper portion of the walls of the canyon. One of the dikes is from 250 to 300 feet wide, nearly vertical, and trends N. 10° W. The structural lines in the gneiss and schist have nearly the same strike, and the apparent bedding and planes of schistosity dip eastward at an angle of from 70 to 80 degrees. At many localities along the river the lower portion of the canyon walls, up to a height of, in general, 800 to 1,200 feet, are composed of the older group of rocks and are bold and precipitous. At the summit of these steep lower slopes there is usually an irregular terrace, due to the more rapid recession of basalt which overlies the more ancient mica-bearing rocks, while the upper portion of the canyon walls, 500 to 1,000 feet in height, according to the irregularities of the subbasaltic floor, is diversified by alternate promontories and recessions. The summit of the canyon walls is frequently marked by a rim rock formed by the edge of the topmost layer of basalt which forms the surface of the bordering uplands. The great forest-covered plateau in which the North Fork has sunk its channel rises, with a gentle gradient, toward the east, and the basalt which underlies it grows gradually thinner when traced in that direction, although there are many important irregularities in thickness, and the influence of the underlying rocks on the topography of the canyon walls becomes more and more marked.

When the region traversed by the North Fork is studied in detail, it will probably be found that there is a progressive change in the rocks beneath the basalt, in reference to metamorphism, from west to east, until the granite, which begins near Rocky Crest and extends at least 20 miles eastward from that peak, is reached. This is seemingly

in keeping with the conclusion reached by Lindgren, that the granite of the Bitterroot Mountains is intrusive and has altered the rocks along its contact; but the greater part of the metamorphism observed in the rocks along the North Fork is probably regional and of older date than the granite.

At Orofino, for several miles both up and down each side of Clearwater River, and also along Orofino Creek for a distance of 2 or 3 miles from its mouth, the mica-bearing rocks beneath the basalt are well exposed. In this region the sublava formations are mainly gneiss, mica-schist, crystalline limestone, and quartzite. This association is essentially the same as occurs in Snake River Canyon, where black slate also is found, and it is to be expected that slate is also present in the neighborhood of Orofino. The limestone is in well-defined beds, associated with mica-schist. The beds are nearly vertical and strike N. 15° to 20° W., which is also the general trend of all of the conspicuous division planes in the older group of rocks, and shows the influence of a force acting in an east-west direction. In common with all other portions of the canyon in the Nez Perce region in which the older group of rocks is exposed, the topography of the bluffs in the vicinity of Orofino reveals the junction of the overlying basalt with the rocks on which it rests; but, as is common in other instances also, the precise contact is almost always obscured by landslides and talus slopes.

The rocks exposed beneath the basalt near Orofino can be traced continuously along Clearwater River and its south fork to near Kamiah, and appear again in the west wall of the canyon about a mile above that town. The same group of rocks is also exposed along several of the streams which join Clearwater River from the east, as well as along the main stream above its junction with the South Fork. In the lower portions of the canyon walls in the vicinity of Greer, a light-colored diorite resembling granite is the most important member of the older terrane.

In the first 6 miles of its course below the great bend near Keuterville, Salmon River cuts at least three ridges of hard, resistant rocks belonging to the series which occurs beneath the lava. At each of these localities the stream is narrow, and rushes through the flume-like trenches with a swift, foaming current. The topography of the walls of the canyon permits one to trace in even distant views the outcrops of the rocks beneath the lava, and to distinguish their junction with the black, horizontally bedded basalt resting on them. In this canyon, as in many others in the Nez Perce region, the older rocks, consisting largely of light-colored, acid, igneous rock, are more resistant to atmospheric influences than is the basalt resting on them, and form conspicuous shoulders on the lower portions of the mountain-like spurs which extend into the canyon from either side. Where the

basalt descends to the river the trail by which one can traverse the canyon from its mouth to near Keuterville descends also, and follows the bank of the river or runs near it; but where the rocks beneath the basalt are exposed the immediate banks of the river are precipitous, and the trail ascends and crosses the promontory at an elevation of, in general, about 1,000 feet above the bottom of the canyon. Below Deer Creek, which comes from the north and joins Salmon River about 15 miles from its mouth, the river flows over basalt and is bordered by magnificent mountain-like escarpments of the same rock, in which the bedding is essentially horizontal. The basalt continues along the margin of the river to within 4 or 5 miles of its mouth, where, as already stated, it enters a deep, narrow, impassable canyon in quartzite, diorite, and other exceedingly resistant terranes. Some of the finest canyon scenery in Idaho is along this portion of Salmon River and in the still greater excavation made by Snake River near its mouth.

Snake River Canyon between the mouths of Salmon and Grande Ronde rivers presents the most varied and instructive exposures of the sublava formations to be found in the Nez Perce region. Some account of the rocks there laid bare by the excavation of a mighty trench through the lava and deep into the formations on which it rests, as well as of other similar outcrops a few miles below the mouth of Grande Ronde River, in the vicinity of Buffalo Rock, has been given in a previous publication,[1] and although additional facts are here presented much more study must be given to this instructive area before its complete history and the economic importance of its building stone and ores can be presented.

Beginning at the first exposure of the sublava rocks, in ascending Snake River above Lewiston, we find, just west of Waha, on the right or eastern border of the canyon, a bold bluff of ancient porphyry which descends to the river. On the opposite bank there is a small outcrop of the same rock, showing that the river in deepening its canyon in the lava sheets was lowered onto a spur of a buried mountain and cut a channel across it. The precipitous, mountain-like bluff of igneous rock (diorite-porphyry) referred to rises 3,300 feet (aneroid measurement) above the river. From its rounded summit a most instructive view can be had of the deeply dissected lava plateaus about its base. This bluff is at the southwest end of Craig Mountain, and probably formed a small steptoe which rose above the level of the last sheet of Columbia River lava. The basement rocks forming the bluff have been laid bare by the erosion of Captain John and Buffalo Creek canyons, and are well exposed at Buffalo Rock. The walls of Snake River Canyon from above the outcrop of old igneous rocks just mentioned to about 1 mile above the mouth of Grande Ronde River are composed, from base to summit, of horizontally bedded lava,

[1] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4 (1897), pp. 31-36.

showing that a deep valley in the old land surface was there filled by the lava flows. Upstream from the mouth of Grande Ronde River, as briefly described in the publication just cited, the horizontal lava sheets in the canyon wall abut against cliffs of schist which form the precipitous border of a buried mountain. The side of the old mountain slopes at an angle of about 45 degrees, and is free from débris. Its base is evidently far below the level of Snake River. Each successive layer of basalt extends farther and farther over the metamorphic rock, until, at a height of 2,500 feet, the summit of the old mountain is covered and the horizontal sheets of lava above it have an aggregate thickness of not less than 1,500 feet. The strata beneath the lava are generally inclined northward at an angle of 40 to 45 degrees, but in places are nearly vertical. The upper layer of thin-bedded limestone contains indefinite fossils. Beneath the limestone are schists, and farther upstream an immense mass of compact igneous rock of the nature of greenstone (diorite) is exposed in the cliffs which rise steeply from the river to a height of a thousand or more feet. The same rock may also be studied to advantage in the small tributary canyons which come down, with steep gradients, to the main stream from each side. Farther up Snake River there are associated with the greenstone extensive outcrops of fine, even-grained diorite (granite) suitable in every way for architectural uses. This "granite" has been opened by quarrying on each side of the river near where Corral Creek joins it, as well as at another locality a mile or two below.

The rocks beneath the basalt are exposed in the lower 2,000 feet of the canyon of Snake River all the way upstream from Corral Creek to above the mouth of Salmon River, but they were examined by the writer at only one locality, namely, where Cougar and Cottonwood creeks descend the eastern escarpment. The creeks referred to are small streams, fed principally by springs which come out at the base of the basalt, but they have cut deep canyons in sandstone, shale, limestone, and diabase-porphyry. The stratified rocks are much disturbed, but in general the beds strike about northeast and southwest, or directly across the course of Snake River. The dip of the beds shows great variation, indicating that the beds were disturbed, largely, perhaps, on account of the intrusion of porphyry beneath and among them, forming dikes. The sandstone is coarse, feldspathic, and hard, and contains well-rounded pebbles of dense igneous rock. Certain layers are exceedingly coarse, being in reality conglomerates, containing water-worn pebbles 6 or more inches in diameter. The shale is fine-grained, black, frequently has a glossy surface, and on weathering breaks into sliver-like fragments a few inches long and a fraction of an inch in diameter. Its thickness is evidently great, probably a thousand or more feet, but owing to the disturbances it has suffered it can not easily be measured. It is

especially well exposed along Cougar Creek, where it immediately underlies the basalt. Limestone occurs on Cottonwood Creek, and forms well-defined layers which show a diversity of dips. At one locality these strata have a thickness of about 60 feet, but in most places they extend to much greater depths. The limestone is compact, bluish in color, and without recognizable fossils. The variety of rocks at the locality referred to and the abundance of good exposures make it a favorable place for a detailed study of the geology and topography of the old land over which the Columbia River lava was outpoured.

In Snake River Canyon, near the mouth of Salmon River, quartzite and diorite are exposed; and the trenches cut through the basalt and a thousand or more feet into the underlying terranes become narrow, with exceedingly rugged and precipitous walls, where the older rocks are exposed.

The geologic age of the sedimentary beds referred to as occurring in the canyon of Snake River is unknown, but, judging from the few obscure fossils obtained and from the result of Lindgren's studies in what is probably a southern extension of the same terranes in Seven Devils Mountains, they probably belong, in part at least, to the Carboniferous.

COLUMBIA RIVER LAVA.

HISTORY.

On the preceding pages many references have been made to the formation here specially considered, the reason being that it forms so important a feature in both the geology and geography of the Northwest that but little can be written about the natural conditions and economic development of that region without frequent reference to it. The rocks here termed the Columbia River lava[1] are exposed nearly everywhere in the canyon walls of the Nez Perce region to the west of the Bitterroot Mountains, and are familiar to all of its inhabitants. They were poured out in a molten condition, and hence come under the general meaning of the term lava, but more definitely, and from the point of view of the petrologist, they should be designated basalt. Either of these terms may be used in referring to them.

The lava in the region under review is a part of a terrane that is among the most widely distributed of the geologic formations of the continent. Its exact boundaries have not been traced, but enough is known concerning them to determine approximately the area it occupies. It lies almost entirely within the drainage area of Columbia River, for which it is named, forming the surface over nearly the

[1] In previous reports this formation has been termed *Columbia lava;* but to avoid confusion with the *Columbia formation* of the Atlantic States, it has been thought best to change the name to *Columbia River lava.*

whole of Washington and Oregon to the east of the crest of the Cascade Mountains, and extending into Idaho until it meets the older formations, principally mica-bearing metamorphic rocks and old eruptives which form the Cœur d'Alene and Bitterroot mountains. The same great series of lava sheets extends into southern Idaho, where they have been deeply trenched by Snake River. The area of the formation is estimated to be 200,000, possibly 250,000, square miles, and its greatest known thickness more than 4,000 feet.

The lava was outpoured at successive intervals embracing a long period of time, as is shown by the occurrence, at several horizons, of layers of sedimentary material, principally clays and sand, between the lava sheets. In places, also, the lava sheets are separated by layers of volcanic dust containing the silicified trunks of trees which grew on a soil formed by the decay of the underlying layer, thus showing that the intervals between the flows were in some cases a century or more in duration. The lava came through fissures in the earth's crust—in what are known as fissure eruptions—and spread widely over the land, from which it is evident that each sheet was spread out horizontally. The movements that have occurred in the layers since they cooled and hardened, and which have caused them to be deformed from their original horizontal position, can be studied in the same way as the structure of sedimentary beds. Although the lava sheets are still essentially horizontal over broad areas, they frequently have gentle dips, and in certain regions are tilted and even sharply folded and faulted. On the eastern slope of the Cascade Mountains the lava sheets occur with a dip to the eastward, for long distances, of 3 or 4 degrees, showing that a large part of that range has been elevated to a height of at least 6,000 feet since the lava was poured out. Similar but less extensive deformations have also occurred on the eastern side of the lava-covered country, as will be described further on. Between these bordering areas is the region of the Great Plains of the Columbia, and southward from it, in Oregon, the lava sheets have, in general, been but little disturbed from their original horizontal position, although a subsidence of three or four thousand feet has probably taken place. Extensive movements in the earth's crust occurred also at certain periods during the time the lava sheets were being formed, as is shown near Clealum, Washington, on the eastern slope of the Cascades, where the upturned and eroded lower portion of the formation is overlain unconformably by later sheets. How widely extended this unconformity may be remains to be determined.

The fact that the Columbia River lava came to the surface through fissures, as molten rock, and that it spread widely over the land, is shown not only by the generally level condition of much of its surface as it exists to-day, and by the absence of volcanic mountains, cinder cones, etc., in connection with it, but is demonstrated in a most

instructive manner where denudation has exposed the dikes formed by the cooling of the liquid magma in the fissures through which it was forced to the surface. Over an area of at least 400 square miles on the eastern slope of the Cascade Mountains in Washington, to the south of Mount Stuart, the lava has been eroded away so as to lay bare the rocks on which it formerly rested. In the surface there exposed many hundreds, probably thousands, of dikes are to be seen. These dikes, composed of dense basaltic rock, range in thickness from a few feet to 160 or more feet, but in general they are from 15 to 60 feet across. They stand nearly vertical, usually with a slight inclination to the westward, and in general trend about N. 15° E.[1]

The vast lava flows just considered spread over the land surface like an inundation, covering the broad plains and extending far into the valleys previously eroded in the slopes of the bordering mountains. Although the lava is of volcanic origin, its surface presents marked contrasts to the topographic changes produced by eruptions through definite and circumscribed vents. Volcanoes generally tend to roughen the surface where they occur, and to build up mountains, thus increasing the diversity of the relief. Fissure eruptions, on the other hand, owing to the vast volumes of liquid rock poured out, tend to spread out widely and to obliterate the inequalities of the land over which they flow, and produce horizontal surfaces. For this reason it is safe to assume that the entire region occupied by the Columbia River lava was a monotonous plain nearly as level as the ocean's surface at the time each successive sheet of molten rock was outpoured. The surface was no doubt rough and strewn with broken fragments of the first-formed crust, and, as cooling progressed, it was in places forced up into mounds and low ridges, which were probably cracked open at the top, as is the case to-day on the very fresh lava sheets forming the Snake River plains; but these small features would not detract from the general monotony. Again, some diversity of surface was no doubt produced owing to the unequal extent of the various lava flows. Although individual sheets are known to have a great area—their edges as exposed in canyon walls in many instances being traceable for a score or more of miles without noticeable variations in thickness and without any indications of approaching a limit—it is not to be supposed that each one had precisely the same extent as its predecessor, and differences in elevation from this cause are to be surmised.

Where a lava sheet was thickest a greater amount of vertical shrinkage on cooling would occur than where it was thin, and in such depressions shallow lakes would form. The greatest influence on the streams, however, occurred from the fact that the lava invaded the lowlands and entered the lower portions of the valleys in the mountains, thus

[1] A preliminary paper on the geology of the Cascade Mountains in northern Washington, by I. C. Russell: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 121-122.

CANYON OF SNAKE RIVER NEAR WAHA.

obstructing the drainage and furnishing conditions for the origin of extensive lakes. The truth of this deduction is verified by the presence of lacustral deposits, some of them of great thickness and wide extent, interbedded with the lava sheets.

The age of the lava, as determined principally from the fossil plants contained in the sedimentary layers and beds of volcanic dust interstratified with it, is Tertiary. It seems to have been outpoured mainly during the medial division of the Tertiary, or during the Miocene epoch.[1] The time when the eruptions ceased has not been determined, and if the lava forming the Snake River plains in southeastern Idaho is included in the same formation as that of the central portions of Oregon and Washington, it will probably be found to extend into late Tertiary, or possibly into the Pleistocene division of geologic time.

In the history of the Columbia River lava Nez Perce County and the country adjacent on the east occupy an important place, for there the lava met the mountains which form the eastern border of the region it inundated. Although the western shore of the sea of molten rock in the same latitude is not definitely known, it was to the west of the present crest line of the Cascade Mountains and at least 250 miles distant.

The lava is well exposed in the canyon walls throughout the region under consideration, all through the Palouse country and the Great Plains of the Columbia in Washington, and throughout central and eastern Oregon. In the central portions of each sheet the rock is usually compact and massive, nearly black in color, and is typical basalt. As determined by J. S. Diller,[2] it is composed of plagioclase, augite, olivine, and magnetite, with considerable globulitic base. An exception to the prevailing characteristics of the lava occurs in the rock on the eastern side of Snake River Canyon, at Corral Creek, and again near the junction of Snake and Salmon rivers. At each of these localities, at a depth of about 2,000 feet below the top of the formation, there are exposures of a sheet of black rock, from 90 to 100 feet thick, which contains crystals of labradorite an inch or more across. Below and above this sheet are layers of the normal and in places markedly characteristic Columbia River lava. In the central portions of thick sheets the rock is frequently columnar in structure, illustrated by a conspicuous example at what is known as the Candle Rocks, on the left bank of Snake River about 3 miles below Lewiston. While the central portions of the sheets are hard, compact, without steam holes, and frequently are conspicuously jointed, their upper and lower portions are irregularly and confusedly jointed, and usually are scoriaceous. The scoriaceous layers are likely to be of a reddish color; occasionally they are bright red,

[1] F. H. Knowlton, Bull. U. S. Geol. Survey No. 108, pp. 103-104.
[2] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4, p. 43.

due to the oxidation of the iron which they contain. The number of separate sheets in an exposure, as in the wall of a canyon, for example, is usually difficult to determine, on account of the disintegration that has occurred and because of the prevalence of talus slopes and landslides, but an approximation to the actual number can be made by counting the layers where the rock is sufficiently massive to stand in vertical walls. On the sides of Snake River Canyon between Asotin and the mouth of Grande Ronde River, where the cliffs are about 2,000 feet high, from 12 to 15 sheets of lava are exposed. An estimate made in the same canyon, near Corral Creek, by counting the layers of scoriaceous rock, gave a still larger number. The thickness of the sheets is in general from 50 to 150 feet. The appearance of the edges of the lava sheets exposed in the walls of the numerous canyons excavated in it is well shown in Pls. IV and V, *B*, which also indicate the extent to which they are concealed beneath their own débris. On the surface of the plateaus between the canyons such deep decay has occurred that usually no hard rock is seen. In fact one might travel many miles through the cultivated fields above the lava without finding a fragment of rock of sufficient size to show its common features.

The feature of the lava which is of greatest interest in connection with the possibilities of obtaining artesian water is its texture. Is it sufficiently porous to permit water to percolate through it, or should it be classed as impervious? The compact portions of the rock should no doubt be considered impervious; but it is so generally broken into blocks or columns, by joints, that the ability of even thick sheets to retain water in a lower porous layer under pressure is doubted. The scoriaceous surfaces of the sheets where they come in contact are sufficiently open to permit the ready passage of water through them, and if interbedded with clay or some similar material they would furnish one of the requisite conditions for flowing wells. In this connection the sheets of volcanic dust and the beds of sedimentary material interstratified with the basalt demand careful study.

SHEETS OF VOLCANIC DUST.

Between the sheets of Columbia River lava there are, at several localities, beds of almost pure white, fine-grained volcanic dust, which was blown out of some distant volcano and widely spread over the land through the agency of the wind. Exposures of this material, known locally as magnesia, occur beneath the Candle Rocks, on the left bank of Snake River below Lewiston; near Swallow Rock, between Clarkston and Asotin; on Asotin Creek, about 10 miles from its mouth; on Captain John Creek; at several localities in the canyon of Grande Ronde River; and at a number of places on each side of Potlatch Canyon. The exposures referred to, which occur on the west side of

A. SOUTHERN SLOPE OF COTTONWOOD BUTTE.

B. COLUMBIA RIVER LAVA IN SALMON RIVER CANYON.

Snake River, probably belong to a single sheet, the position of which is about 200 feet below the surface of the topmost layer of lava as it exists to-day; but most of the exposures are in landslides, and the exact position where they occur in place has not been determined. The evidence seems to indicate that in the region under review there are several layers of volcanic dust, some of them mingled with sedimentary material. These deposits are of special interest in connection with the question of obtaining artesian water, as the coarser layers more particularly are sufficiently porous to permit water to percolate through them. This is shown not only by their texture but by the fact that in certain instances, where their edges are exposed, springs come to the surface, the water having a peculiar opalescent or slightly milky appearance, due to the exceedingly fine particles of dust held in suspension. These layers frequently contain fossil leaves, which afford excellent illustrations of the nature of the varied and luxuriant flora which clothed the lava plain at the time the dust showers occurred, and also serve to define the stratification of the lava sheets with which they are associated, and, further, they are of economic importance, as will be shown further on.

Near the heads of many of the small streams, particularly at the lower extremities of small gulches, down which there is only an occasional flow of water, there are, throughout a wide extent of territory in eastern Washington and adjacent portions of Idaho, small surface deposits of fine white material, usually designated by herdsmen and others as alkali. If examined under a microscope, however, this material will be found to be composed of small angular grains and shreds having a glass-like appearance; to be, in fact, volcanic dust, which chemical analyses prove it is. The deposits referred to are usually from a few inches to 6 or 10 feet, possibly more, in thickness. Characteristic examples occur on Cottonwood and Cougar creeks, which flow into Snake River; about the mouth of several of the small gulches opening into the canyon occupied by China Creek, and elsewhere, particularly in the southern portion of Nez Perce County. In all of these instances the dust has accumulated in alluvial cones or flood plains near the mouths of gulches which are usually dry, and has not been noted where the conditions favor rapid transportation. Evidently it was brought down by brooks and rills flowing through the small ravines and gulches at the mouths of which it is now found, and was deposited at a recent date. The probable explanation of these occurrences is that a light shower of volcanic dust occurred over the Northwestern States not many years ago, and that the material has been washed from the steeper slopes and in part accumulated in the flood plains and alluvial cones of small, particularly of intermittent, streams. The larger streams, which must also have received their share of the material, being able to carry it away, evidence of the shower is now to be found

in only sheltered situations. That these accumulations of volcanic dust are not due to the washing out and redeposition of the similar material from between the sheets of the Columbia River lava is shown by the fact that characteristic examples of the deposits occur at the mouths of gulches which drain areas of the older group of rocks only, as, for example, on some of the tributaries of Cougar Creek, from which the lava has been removed by erosion and deep trenches excavated in the shale, limestone, etc., beneath.

An analysis of a characteristic sample of the dust from Cottonwood Creek, one of the small tributaries of Snake River, in the southern part of Nez Perce County, is given herewith, which shows that it is richer in silica, potash, and soda than the basalt which forms the Columbia River lava. Evidently the fissure eruptions which furnished the basalt can not be responsible for the dust, which must have come from some distant volcano in a state of explosive eruption and discharging acid lava. The fineness of the dust, which frequently equals that of ordinary wheat flour, also indicates that it was brought from a distance by the wind, all coarse particles being dropped on the way.

Analysis of volcanic dust from Cottonwood Canyon, Idaho.

[W. F. Hillebrand, analyst.]

Constituent.	Per cent.	Constituent.	Per cent.
Silica (SiO_2)	68.95	Titanium oxide (TiO_2)	0.42
Alumina (Al_2O_3)	14.33	Zirconium oxide (ZrO_2)	0.06
Ferric oxide (Fe_2O_3)	1.17	Phosphorus pentoxid (P_2O_5)	0.16
Ferrous oxide (FeO)	1.23	Chlorine (Cl)	(?)
Magnesium oxide (MgO)	0.47	Fluorine (F)	(?)
Calcium oxide (CaO)	2.13	Sulphur (S)	Trace.
Sodium oxide (Na_2O)	5.08	Manganous oxide (MnO)	Trace.
Potassium oxide (K_2O)	2.58	Barium oxide (BaO)	0.18
Water, hygroscopic (H_2O-)	0.28	Strontium oxide (SrO)	Trace.
Water, combined (H_2O+)	3.63	Lithium oxide (Li_2O)	Trace.
		Total	100.18

The dust referred to became mingled with the soil of the plateau and served to increase its percentage of, especially, silica, potash, and soda. While the dust of the particular shower of which evidence remains can not be considered as having made a notable increase in the richness of the soil in potash, it is possible that older showers, all direct evidence of which has been lost, may have assisted in the same direction, which would explain the greater percentage of potash in the soils of the lava-covered region than is contained in the rocks from which they originated, as will be explained further on.

DEPOSITS OF LAPILLI.

When a lava flow encounters a body of water steam is generated, or the water is, perhaps, decomposed and oxygen and hydrogen are evolved, which, if ignited, cause an explosion. In either case the hot rocks are likely to be blown into fragments, which are covered by the lava in case it continues to advance. The fragments produced in this manner

are angular, frequently of the size of gravel, and on account of the rapidity with which the hot magma cools they usually have a glassy texture, or when broken resemble bits of overburned earthenware. Deposits of this material known as lapilli occur in the Columbia River lava at several horizons, but usually seem to be local in their distribution. A characteristic deposit, in which the angular, glassy grains are incrusted with a yellowish coating, probably of ferric chloride, is exposed near Swallow Rock, a few miles below Asotin, along the aqueduct which supplies Clarkston with water. Another deposit can be seen above the conspicuously columnar basalt forming a colonnade along Snake River between Clarkston and Alpowa; and others of a similar character but of smaller extent and thickness and usually associated with highly scoriaceous lava, are known at a few other localities in the Nez Perce region. The lapilli is seemingly too local in its distribution to have much significance in reference to the occurrence of artesian water, but as it is associated with the scoriaceous portions of lava flows and occurs between lava sheets, it would favor the passage of water through the rocks. Its principal geologic interest lies in the fact that it furnishes a part of the evidence by which separate lava sheets may be distinguished.

SEDIMENTARY BEDS.

During each interval between the inundation which spread out the sheets of Columbia River lava, the streams from the bordering uplands brought down débris and deposited it on the newly formed surface. When the intervals between the eruptions were long, the quantity of débris swept down from the uplands would increase, and it would be deposited as alluvial cones at the mouths of valleys, or perhaps be spread out in lakes on the lava plains and form deltas or possibly widely extended layers of lacustral sediment. It is therefore to be expected that both fluvial and lacustral deposits will be found at several horizons where a number of lava sheets occur one above another. This expectation has been realized in the Nez Perce region, by the discovery of several localities where beds of clay, sand, gravel, etc., occur between sheets of Columbia River lava. One of the most instructive of these is on the farm of Ira Small, about 6 miles east of Lewiston (sec. 1, T. 35, R. 5), where a well, drilled with the hope of obtaining artesian water, passed through the following strata:[1]

[1] In the first layer of basalt mentioned an inflow of water amounting to about 4 barrels an hour was obtained at a depth of 140 feet from the surface. This fact, taken in connection with observations made elsewhere, indicates that the basalt above the sedimentary beds reported in the section is in reality composed of two separate sheets—the upper one about 140 to 150 feet thick and the lower one from 90 to 100 feet thick. When the drilling had reached a depth of approximately 300 feet, and was at about the bottom of the sand, as stated by Mr. Small, "there was an escape of air which had sufficient force to blow off a 2-inch plank when laid over the top of the well." This so-called air was not inflammable, and may have been carbonic acid gas? At the base of the clay an inflow of water was obtained sufficient for the purpose of continuing the drilling in the underlying basalt, but no water under pressure was encountered. The well is 6 inches in diameter (tool 5¾ inches), and is cased to within about 10 feet of the surface of the lower basalt.

Section about 6 miles east of Lewiston, Idaho.

	Feet.
Soil and subsoil (decomposed lava)	10
Basalt, hard, compact, black	210
Sand (about 60 feet) and clay (from 90 to 100 feet)	160
Basalt, hard, compact, black	75
Total	455

The locality where this boring was put down is near the northern border of the plateau termed in this report the Lewiston Plateau, which at that place slopes gently downward toward the south, in conformity with the dip of the strata beneath it. To the north of the site of the boring, and from a quarter to a half mile distant, is the brink of the south wall of the canyon of Clearwater River, in which are exposed the sedimentary beds penetrated in sinking the well. At this locality, and at the head of a small ravine opening northward into the canyon of Clearwater River, a copious spring outflows at the contact of the layer of sand with the clay beneath, which has been enlarged, by excavation, so as to supply a neighboring farm with water for household use and irrigation. This spring is typical of a large number of springs in the Nez Perce region, and it will be referred to again in connection with certain suggestions for increasing and utilizing the waters of some of the porous sedimentary layers which occur between the lava sheets by excavating "horizontal wells."

The sedimentary beds penetrated in drilling Small's well, and which are exposed in the neighboring gulch, can be traced over a large extent of country in the northern and western portions of Nez Perce County and adjacent portions of Washington and Oregon. They probably extend eastward to the foothills of the Bitterroot Mountains, but as there are other similar layers in that region they have not been identified east of Craig Mountain. All along the sides of the canyon of Snake River from near Lewiston-Clarkston to Buffalo Creek on the east and to the breaks of Grande Ronde Canyon on the west, as well as on the sides of the canyons of the various branches of Asotin Creek, and of Tammany, Sweetwater, and Lapwai creeks, the sedimentary beds referred to are plainly revealed in the topography of the canyon walls. The basalt above these beds has been eroded more rapidly than the layers below, leaving a terrace which, although usually heavily encumbered with talus and landslides, can readily be distinguished. The terrace extends into each side gulch which opens out into the main canyons, and near the heads of these gulches there frequently is a spring. The position of the terrace in reference to the surfaces of the adjacent plateaus between the drainage lines varies from 200 to 380 feet. This variation is due in part to inaccuracies in determining precisely where the base of the soft beds occurs, owing to the débris that is almost invariably present, and to the differences in weathering which the plateaus have experienced. By aneroid measurement the terrace

on the east border of Snake River Canyon near Waha is 200 to 220 feet below the general level of the adjacent plateau; on the border of the canyon of Asotin Creek it is 370 feet below; and on the Clearwater escarpment, which forms the south border of the Uniontown Plateau, it is about 250 feet below. The identification of the sedimentary layer which determines the presence of the terrace referred to is in places rendered somewhat difficult, owing to the presence above it of another layer of similar material, which is separated from it by a sheet of basalt. The nature of these irregularities, which are to be expected in so large an area, is shown by the following section, obtained in the south wall of Asotin Canyon nearly opposite the mouth of George Creek:

Section in Asotin Canyon.

	Feet.
Soil on the slope descending from the plateau surface, with blocks of basalt, exposures poor	120
Basalt, forming a well-defined rim rock	35
Sedimentary beds containing a large variety of well-rounded pebbles, some of them 3 to 5 inches in diameter	110
Basalt, forming a bold escarpment, in places broken off and fallen in landslides	150
Sedimentary bed, soft, apparently clay	140
Basalt, scoriaceous at top and bottom; compact in central part, but showing 4 or 5 partings on weathered slopes	390
Total	955

The thicknesses given in the foregoing section are only approximately correct, as the contacts are seldom sharply defined. Judging by the plateau surfaces, the upper layer of basalt on Asotin Creek and at Small's farm are the same, but the sedimentary beds at the former locality are separated by a sheet of basalt about 150 feet thick, and their aggregate thickness is 100 feet more than at the second locality referred to. A tentative explanation of these differences is that a lava flow occurred in the Asotin region which did not reach as far to the northeast as the locality where the drill hole was put down at Small's farm, and that to the east of Lewiston this lava flow practically separates the upper or sandy member of the sedimentary beds from the lower or clayey member. The writer confesses, however, that the difference may be owing to errors of observation, as the natural exposures are obscure and are largely interpreted from topographic forms.

What is probably a part of the sedimentary beds just considered occurs on the south side of the Blue Hills, in the walls of the canyon of Grande Ronde River, but there it appears to be thicker than in the vicinity of Lewiston, and it carries one or more beds of lignite. Its presence in the locality referred to is shown not only by actual outcrops, usually, however, in landslides, but in a conspicuous manner by the topography. On the north side of the river, where the strata dip

toward it at a low angle, there have been a great number of large landslides, but on the south side, where the strata dip away from the face of the precipices, the cut edges of the beds stand nearly vertical. and the presence of the soft layer near the summit is revealed by a well-defined terrace.

An important feature in reference to these sedimentary beds is that when two beds are present, as along Asotin Creek, the upper portion of the formation is composed of sand and gravel, and is so open that water could flow freely through it. In many instances, as on the escarpment forming the south border of the Uniontown Plateau, the gravel contains well-worn pebbles 5 to 6 inches in diameter. The lower portion of the formation, however, is clay-like and is practically impervious. Water descending into the sandy and gravelly portion of the formation is arrested by the basalt or the clay beneath it, and there flows laterally, thus accounting for the springs which appear where the beds are cut by canyons. These springs occur at only certain localities, especially near the heads of small gulches, as in most places the outcrops of soft beds are covered with loose material which has fallen from above. The large number of canyons, which have been cut to a greater depth than the base of the sedimentary beds, in most instances precludes the possibility of their receiving water from the mountains. and all of the water which issues as springs, or which may be obtained by excavating tunnels, must be supplied by the local rainfall. And. on account of the deep dissection of the plateaus, it is not to be expected that the water in the porous beds referred to could exist under sufficient pressure to supply artesian wells.

At Denver and Cottonwood, situated on the Camas Prairie within the region occupied by the Columbia River lava and at a distance of from 8 to 15 miles from its eastern border, borings (the detailed records of which will be presented further on) have been made, which show, in connection with natural exposures and the topography of the walls of neighboring canyons, that sedimentary beds of considerable thickness underlie the surface sheet of basalt. At Cottonwood the surface layer of basalt is from 60 to 70 feet thick, as shown by a boring. and rests on a sheet of gravel which has been penetrated to a depth of 56 feet without reaching its base. At Denver, where several borings have been made, the surface sheet of basalt appears to be broken and largely disintegrated, as the drill penetrated only loose material to a depth of about 200 feet. Terraces on the sides of canyons and occasional outcrops in their walls in the same region indicate that over a large portion, perhaps the whole, of the Camas Prairie, layers of open and porous sedimentary material are probably present beneath the surface sheet of basalt.

Along the canyon of the South Fork of Clearwater River, from Stuart to the vicinity of Peck, there are occasional outcrops of sand-

stone and allied rock, mostly, however, in landslides, which indicate the presence of a thick sheet of similar material, the surface of which is about 800 feet below the general level of the adjacent plateaus. The chief evidence of the presence of this important bed of soft material is furnished by the vast number of landslides that have occurred. Where the river has not cut below the level of the bed referred to its canyon widens, as at Kamiah, and its sides are formed by hundreds of displaced masses of basalt which have fallen from above. A view taken near Kamiah (Pl. IX, *A*) exhibits some of the topographic forms referred to.

Throughout the length of Orofino Creek, from its mouth to near Pierce City, there is an almost continuous series of heavy landslides on each side of the creek, which indicates the presence of incoherent beds at least 200 or 300 feet in thickness, beginning at a depth of about 750 feet below the surface. These strata are probably a continuation of those which have so greatly influenced the topography of the wall of Clearwater Canyon near Kamiah and elsewhere. Their character is shown by outcrops of sandstone and shale carrying lignite which are exposed in the bed of the creek at several localities.

Along Little Canyon Creek, which drains a portion of the broad plateau to the south of Orofino, coarse sandstone associated with carbonaceous shale occurs just at the base of the precipitous canyon walls and beneath 800 feet of horizontally bedded basalt. The thickness of this bed is not exposed, but it evidently is considerable, as the water percolating from it is sufficient to maintain Little Canyon Creek throughout the dry summer months.

Again, in the canyon of Potlatch Creek, which joins Clearwater River from the north about 18 miles east of Lewiston, there are several outcrops of sedimentary beds interstratified with the Columbia River lava. In ascending the canyon the first of these exposures is on its western side, about 3 miles from its mouth, where some grading has been done for a wagon road. There is shown a thickness of about 25 feet of sedimentary material, consisting largely of volcanic dust, at a height of approximately 80 feet above the canyon's bottom. Neither the top nor the bottom of the deposit was seen, and it is probably a part of a large landslide. This layer is impervious, and a spring finds an outlet just above it. A half mile farther upstream, and about 250 feet above the canyon's bottom, there is a small exposure, 3 to 4 feet thick, of yellowish sandstone carrying pebbles. On the wagon-road grades which ascend the steep eastern side of the canyon near Juliaetta, there are at least three outcrops of sedimentary beds, one of which is evidently in place, or has moved but a short distance down the slope from its true position. It is 250 feet below the general level of the neighboring plateau, and consists of coarse granitic sand spangled with mica. A thickness of 8 feet is in sight. Resting on this is a

layer of sandy, micaceous clay, a thickness of 2 feet of which is exposed. Two other outcrops of sedimentary material at lower levels consist mainly of volcanic dust, and are apparently portions of landslides. While owing to the prevalence of landslides and talus but little information was obtained concerning the true position of these beds, the differences between the limited outcrops observed show that at least two important sheets of sedimentary origin underlie the adjacent plateaus. One of these beds is of open texture, and permits the free percolation of water, the other, or lower, is clay-like and impervious. The direct connection of these beds with the sheets of similar material in the cliffs bordering Clearwater Canyon on the south, between Spalding and Lewiston, which are penetrated by the well at Small's ranch, has not been traced, but it is probable that they belong to the same layers. While the elevations of the outcrops at these two localities differ, owing to the movements that have occurred in the rocks, the depth of the sedimentary sheet below the surface of the broad plateaus should be in each instance approximately the same.

In the canyon of Salmon River near the mouths of Eagle and Deer creeks, for a distance of 3 or 4 miles along its western border, and extending a mile or more up the sides of each of the creeks, there are five exposures, from 20 to 55 or more feet in thickness, of coarse, yellowish sandstone containing well-rounded pebbles and fragments of silicified wood. This bed of sandstone is at a depth of approximately 3,500 feet in the Columbia River lava, and has beneath it a bed of lava with a rough scoriaceous surface. One of the outcrops referred to, on the west side of Salmon River just above the mouth of Eagle Creek, is interrupted by a promontory of crystalline rock which rises into the overlying lava sheets, having formed an island or cape in the waters in which the sandstone was deposited. Such an interruption in a porous water-bearing sheet illustrates one class of difficulties to be expected in attempting to obtain artesian water from the sedimentary beds interstratified with the Columbia River lava. That is, the old land surface over which the lava spread was irregular; the ancient peaks and ridges rise into the lava to varying heights, some of them, as already noted, remaining as steptoes when the last and highest lava sheet flowed about them, while others, and probably by far the larger number, were buried to greater or less depths and can only be discovered when denudation has unearthed them or the drill in its descent encounters them. As will be shown more fully further on, these buried peaks and ridges of impervious rock may cut off the supply of water from an otherwise favorably located porous layer.

SUMMARY.

In addition to the observations already noted, others might be cited to prove the presence of sedimentary beds between sheets of Columbia River lava, but they are of a qualitative nature and pertain princi-

A. SANDSPIT IN NORTH FORK OF CLEARWATER RIVER.

B. CANYON OF SNAKE RIVER FROM CRAIG MOUNTAIN.

pally to the presence of such material in landslides. What is desired are definite measurements of the thickness of the sedimentary deposits and their depth below the surface; but such quantitative observations are difficult to obtain, owing to the peculiar conditions which exist, especially with reference to the disintegration of the rocks in natural outcrops and the tendency of soft beds beneath lava sheets to give origin to landslides. The depth at which a widely extended layer of clay, sand, gravel, etc., occurs beneath the surface varies from place to place, owing principally to movements which have affected the rocks over broad areas and the amount of surface denudation. From such facts as are in hand it is evident that in the Nez Perce region, where extensive lava plateaus occur, the presence of porous water-bearing beds is to be expected at three principal horizons, namely, at 150 to 350 feet, at 750 to 1,000 feet, and at 3,500 to 3,600 feet. Although the beds at these approximate depths below the plateau surface in which the stratification is essentially horizontal, are widely extended, yet at certain localities where the lower beds especially might be expected to occur, they have not been found. In Snake River Canyon above Asotin, where the sedimentary beds would be expected to appear at the horizon 750 to 1,000 feet below the surface, no evidence of their presence has been obtained. A more careful search may reveal them, but it is evident that if there were present a stratum of sandstone of the thickness and character of the one near Orofino it would have a decided influence on the topography of the canyon walls, and such testimony is wanting. The conclusion to be drawn from this negative evidence seems to be that the beds under consideration did not reach the locality referred to, possibly on account of intervening ridges of the pre-lava formations which cut off the streams from the Bitterroot Mountains.

The general history to be read in these sedimentary beds is that the material of which they are composed was brought by streams from the mountains bordering the Columbia River lava on the east and spread out over the lava from time to time, during the intervals between the eruptions, as alluvial fans and as lacustral deposits. The material thus spread out should become finer and finer when traced away from the mountains that supplied it, and in the case of the beds of sand and gravel it should thin out in the same direction. Such beds should also be more numerous near the eastern border of the lava plateaus than farther west, for after each lava flow some material would be washed down upon it from the mountains, but during only the longer intervals would widely extended alluvial fans be formed. For this reason it may be concluded that the probabilities of obtaining artesian water should increase as the eastern margin of the last lava flow is approached.

While the beds of sand and gravel referred to should be considered mainly as stream deposits, they may be in part the shore foundations

of lakes into which the streams flowed. There is no means of determining from occasional exposures under which of these two methods sand and gravel may have been laid down, and in fact the stream-laid beds and the layers of coarse material found in the shallow portions of lakes merge into the others by insensible gradations. The fine clays, however, such as those underlying the region about Lewiston at a depth of 280 to 300 feet below the surface of the level plateaus, were evidently deposited in lakes, and may be widely extended without exhibiting marked variations in thickness. During the intervals between many of the eruptions lakes probably existed on the surface of the lava, and they would lay down sheets of clay-like material of variable thickness, dependent largely on the length of time they existed; but the positions of the lakes can not be predicted. It is expected, however, that lacustral deposits will be found widely distributed throughout the Columbia River lava, and as they are in general composed of impervious beds, one of the conditions requisite for the storage of water under pressure—artesian—may be present in even the central portion of the lava-covered country. This statement in reference to the probable wide extent of lacustral deposits interbedded with the lava is not based entirely on general principles, as thick and widely extended foundations of the nature referred to are known to exist in west-central Washington. On the whole, what is known of the sedimentary beds, whether fluviatile or lacustral, interbedded with the Columbia River lava is favorable to obtaining artesian water over a widely extended region embracing portions of Washington, Oregon, and Idaho.

SOILS.

As is well known, the material forming soils is composed chiefly of disintegrated and more or less thoroughly decomposed rock débris. This débris either remains in essentially the position where it originated or is removed from that position and redeposited elsewhere. Two leading classes of superficial accumulations are thus produced, termed sedentary deposits and transported deposits, in each of which important subdivisions have been recognized. So far as the Nez Perce region is concerned, the representatives of the sedentary deposits are such as have originated from the disintegration and decay of rocks in place, and they may be termed residual soils; while the superficial material which has been brought from a distance and redeposited, found principally along the margins of the rivers, forms alluvial soils.

RESIDUAL SOILS.

The character and mode of origin of the soil in a typical portion of the great region occupied by the Columbia River lava has been discussed in a previous report,[1] and but little information in addition to

[1] A reconnoissance in southeastern Washington, by I. C. Russell: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4 (1897), pp. 57-64.

what was then presented can be given at this time. The soils covering the broad plateau surfaces in the Nez Perce region and streaming down their steep bordering escarpments are similar to, in fact practically identical with, the soils about Pullman, Washington, described in the report just referred to. Throughout the lava-covered portions of Oregon, Washington, and Idaho and the bordering uplands, composed of older terranes, the soils have resulted from the disintegration and decay of the underlying rocks, and in genenal have been removed but short distances, if at all, from their original positions. This conclusion is sustained by the fact that when the surface material is traced downward it is found to change, frequently by insensible gradations, into the underlying and still solid rock; also by comparing the chemical composition of the soil and subsoil with that of the unaltered rocks beneath, and by noting the surface changes in passing from one geologic formation to another. In traveling from the lava plateaus to the adjacent uplands of older rocks, such as limestone, granite, diorite, schist, etc., in the foothills of the Bitterroot Mountains, an immediate change in the character of the soil forces itself on one's attention. Above the lava the soil is fine and of a dark color, owing, principally, to the presence of organic matter, while the subsoil, equally fine in texture, is always of a dull yellow or a brownish yellow color, and is characteristically without pebbles or sand grains visible to the unaided eye, while the soils on the older rocks are usually light colored and contain sand, angular fragments of rocks, and minerals the nature of which can readily be determined and which corresponds with that of the underlying rocks. The chemical composition of these two divisions of residual soils shows marked differences, in harmony with the obvious fact that the soils of the lava plateaus are more productive than those of the older formations.

Compared with the older rocks adjacent to it, the greater rapidity with which the Columbia River lava breaks down and changes its physical characteristics is shown by the increased fineness and far more complete decay of the residual material produced. This is the more striking when it is remembered that the region composed of the older terranes above the level of the last sheet of lava has been much longer exposed to the influences which produce weathering than the more thoroughly decayed surface of the lava. That this difference is not due to differences of slope or of exposure—the surface of the lava being frequently nearly flat, while the surface slopes of the older terranes are more generally inclined, thus favoring the removal of small particles and resulting in a concentration of the larger fragments—is evident from the fact that the older land has a great variety of surface slopes and that on all of them the débris is much less thoroughly decomposed than on the lava plateaus or even on the steep escarpments forming the walls of the canyons excavated in the lava.

The fact that the soil on the lava plateaus is not mainly a dust deposit

brought from a distance by the wind, as its fineness might indicate and as has been suggested by certain careful observers, is clearly shown by the abrupt change, just referred to, observable in the surface material on passing from the lava to the bordering upland and particularly on visiting the steptoes which rise in isolated positions through the lava. On Steptoe and Kamiah buttes in Washington, on Cottonwood Butte in Idaho, and on other similar island-like areas, or steptoes, of pre-Tertiary terranes rising through the Columbia River lava there is an abrupt and frequently conspicuous change between the soil of the buttes and that of the surrounding plateau. The soils on the various steptoes also differ from one another, but all contain fragments of the underlying rocks. These observations are evidently not in harmony with the suggestion that the soil of the wheat lands has been brought from a distance by the wind.

The great importance of the wonderfully rich soil on what may be termed the wheat lands of the region under consideration is sufficient excuse for repeating certain observations concerning it, which were published in the report already cited. In the following table there is given the results of analyses of a sample of basalt, a representative of the Columbia River lava, collected at Wallawalla, Washington, and of the subsoil and soil resting on the same formation at Dayton, Washington. The subsoil is from a depth of 30 feet, and the soil was collected in a wheat field at a depth of 2 feet below the surface. Each of these samples is characteristic of the material from which it was taken over a wide extent of country.

Analyses of basalt, subsoil, and soil from Wallawalla and Dayton, Washington

[George P. Merrill, analyst.]

Constituent.	Basalt.	Subsoil.	Soil.
	Per cent.	*Per cent.*	*Per cent.*
Silica (SiO_2)	47.35	65.89	63.5[illegible]
Alumina (Al_2O_3) } Iron oxide (Fe_2O_3)	34.38	22.19	22.36
Magnesia (MgO)	4.43	1.85	1.8[illegible]
Lime (CaO)	8.27	2.36	2.7[illegible]
Soda (Na_2O)	2.55	2.08	2.[illegible]
Potash (K_2O)	1.33	2.36	2.[illegible]
Loss on ignition (principally organic matter)	.95	2.60	4.37
Total	99.26	99.33	99.1[illegible]

In reference to these analyses, Merrill says:

All of the material analyzed was first dried at 100° C. The analyses are not as detailed as I would like to make, but are all that the limited time permits. Perhaps the most striking fact in the analyses is the similarity in composition between the surface soil and that from a depth of 30 feet; almost the only essential difference being, apparently, the larger percentage of volatile matter of the surface soil. Not having as yet separated the iron and alumina, I am unable to account for the apparent loss of these constituents shown. From previous analyses I am led to suspect that the iron oxides have been very largely removed. I am unable as yet to account for the apparent increase in potash in the decomposed material. It is possible, though hardly probable, that this is due to errors in analysis.

The close similarity between the composition of the soil and subsoil and of the rock which occurs beneath them is instructive and sustains the conclusion that the surface material has resulted from the breaking down of basalt. In the formation of residual soils the more soluble constituents are removed in solution by percolating water, and the less soluble substances are left as a residuum. The soil and subsoil should therefore contain an increased percentage of the less soluble substances in the original rock, such as silica and alumina, and a smaller percentage of the more readily soluble substances, such as soda, potash, lime, etc. The foregoing analyses are essentially in harmony with this general principle, with the exception of the potash and soda. In the case of the potash there is an increase in the decomposed material above the amount present in the parent rock, while the percentage of soda is nearly the same. This result is so surprising that I fear more analyses should be made before accepting it as final,[1] but it is perhaps not out of place to suggest a way in which potash and soda may have been added to the soil.

Over a large portion of the United States to the west of the Mississippi there have been showers of volcanic dust in recent times. An analysis of some of this material which fell in Nez Perce County has already been given (p. 34), which shows that it carries 2.58 per cent of potash (K_2O) and 5.08 per cent of soda (Na_2O). This material falling on the surface of the plateaus would in most situations not be washed away, but would form an addition to the soil. How many showers of volcanic dust have occurred since the last sheet of Columbia River lava was poured out is unknown; but as such showers occurred during the eruption of the lava, and also at a recent period, it is reasonable to suppose that they took place in the interval referred to. The material thus added to the residual soils would be on its upper surface, although, judging by present conditions, when in general the plateaus are without surface drainage, there would be a transfer of soluble material by percolation from the surface downward. If there has been a notable

[1] In Bulletin No. 9 of the agricultural experiment station at Moscow, Idaho, by Prof. Charles W. McCurdy, and in Bulletin No. 13 of the agricultural experiment station at Pullman, Washington, by Prof. Elton Fulmer and Prof. C. C. Fletcher, a large number of soil analyses are given, and of those the samples for which came from the region occupied by the Columbia River lava, only one contains potash in excess of 1 per cent, while the average is about one-half of 1 per cent. The exception referred to is in the case of the subsoil from near the experiment station at Moscow, analyzed by McCurdy, which is reported to contain 1.83 per cent of potash. The soil at the same locality contained but 0.59 per cent of potash. This analysis is vitiated, however, for our present purpose, as "sand and silicates" are reported present to the extent of 73.77 per cent; what is included under the term silicates is questionable. In a large number of analyses of the soils of Washington by Fulmer and Fletcher, in which there seems to be no ambiguity of the nature just referred to, the potash reported is always considerably less than 1 per cent. The geologic relations of the soils analyzed is not always stated, but a number of these are certainly from localities which are underlain by the Columbia River lava. In a summary, in reference to the presence of lime, phosphoric acid, and potash in the soils of Washington, embracing the results of 45 analyses, the maximum, minimum, and mean percentage for potash are 0.6428, 0.0354, and 0.3049, respectively. There is thus a serious discrepancy between the analyses just cited and those by Merrill given on page 44, in reference to the percentage of potash in the soils of the Columbia River lava region, which will have to be diminished before the discussion of the origin of the soils from a chemical standpoint can satisfactorily be continued.

addition of volcanic dust to the surface of the residual soils on the lava, analysis may reasonably be expected to show a greater percentage of potash in the soil than in the subsoil, but this supposition is not sustained by the chemical evidence available. Again, the beds of volcanic dust interstratified with the Columbia River lava may have contributed material to the soils formed by their decay and enriched in potash. The volcanic dust referred to is of the same physical character as that of which an analysis has been given, and with little doubt is of about the same chemical composition.

A typical illustration of the nature of the soil and subsoil produced by the disintegration and decay of basalt is afforded at an excavation made for clay at a brickyard in Uniontown. The material there used for brick making is the normal subsoil of the wheat lands. It is about 35 feet thick, but the passage to the solid rock beneath was not exposed at the time it was visited. The material is fine in texture, in fact is almost without appreciable grains, and is of a uniform brownish yellow color, except that the upper 4 or 5 feet, as seen in vertical walls, is darkened by organic matter. There not only is no evidence of stratification, but the material is uniform in color, texture, etc., from the base of the discolored upper portion to the bottom of the exposure, a depth of about 25 feet. The most interesting feature is the presence of nearly vertical but somewhat tortuous tubes, having an approximately uniform diameter of one-fourth inch, which occur at intervals of, in general, from 4 to 6 inches. These tubes can easily be traced in the walls of the excavation for distances of 5 or 6 feet, and seem to be continuous from the base of the layer of soil to the bottom of the exposure. They are so nearly vertical that the gentle bends or irregularities in direction seldom cause them to depart more than 4 or 5 inches from a mean position. They do not bifurcate or send off branches, and have no definite walls. They are simply holes in the soft, clay-like material traversed by them. On their interiors there are slight irregularities, such as might be produced by the downward flow of drops or small clots of the material which they traverse, which have hardened so as to form slight elevations with well-defined and rounded lower margins.

A tubular structure like that just described is somewhat exceptional in the residual soils on the Columbia River lava, but it has been observed in a few other instances. More commonly much smaller tubes are present, similar in every way, except, perhaps, in the character of their bounding surfaces, with diameters rather uniformly about one-tenth of an inch. These small tubes were not observed in the subsoil at Uniontown, but in many other instances, in material of the same character, they were so numerous that a cubic inch of the subsoil could not be examined without finding several of them.

The origin of either class of these tubes is unknown, but it is obvious that they serve an important function in permitting the ready absorp-

tion of rain water falling on the wheat lands, and show, in fact, why there seldom is any evidence of surface rills. Slopes of fully 25 to 30 degrees, composed of soft soil in either its natural condition or plowed, harrowed, and left unsown for a year, a common custom, show no rill marks such as are usual in many regions, especially where the soil is an impervious clay. The open tubes in the subsoil insure a prompt and most effective underdrainage and aeration, and the soil in which it is presumed the tubes have been obliterated, through movements in the material, due to the beating of rain, the growth of plants, frost, etc., is so exceedingly fine—less than 2 per cent of the grains exceeding one-tenth of a millimeter in diameter[1]—that all of the water falling on it is at once absorbed. While the rate of evaporation is high, the soil does not become charged with alkaline salts, as is so commonly the case in regions of small rainfall—the water from below being raised to the surface by capillary attraction, and the salts it contains being precipitated as evaporation progresses—but on account of the prompt subdrainage by percolation, where rain occurs, the material brought to the surface during dry seasons is redistributed. The only localities on the plateaus underlain by Columbia River lava where alkaline salts are concentrated at the surface are in low basins where an excess of organic matter has rendered the soil impervious; but these places are of rare occurrence and of small area.

On the precipitous walls of the numerous canyons cut into the Columbia River lava and the older formation beneath, there is usually a mantle of soil not only on the ledges and terraces but on the steep talus slopes and irregular surfaces of landslides. These soils, although usually composed largely of disintegrated and decayed basalt, have in many instances received important additions of material derived from the layers of volcanic dust, sand, gravel, etc., interbedded with the lava, and at horizons below the base of the lava sheets they contain also the débris of the pre-Tertiary terranes. The sides of the canyons are nearly everywhere clothed with bunch grass, and in spite of their steepness they afford excellent pasturage. The commingling of débris on the steep plateau margins has led to the making of a soil which in some instances seems to be even better adapted to agriculture and horticulture than the more uniform soils of the plateau surfaces. This may be due in part, however, to more favorable exposure to the sun, but it certainly is influenced by the escape of water from the cut edges of porous layers in the lava formation.

In the case of the terranes of older date than the Columbia River lava, surface disintegration seems to be in excess of rock decay, as the soils are usually charged with rock fragments, while on the lava plateaus the reverse is true, and fragments of rock large enough

[1] See mechanical analysis of a sample of wheat-land soil from Pullman, Washington, by Milton Whitney: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4 (1897), p. 59.

to be distinguished by the unaided eye are of rare occurrence, even at depths of from 20 to perhaps 75 or more feet below the surface. The lava is plainly more prone to decay and to crumble under the influence of percolating water than is the granite, diorite, gneiss, schist, limestones, etc., of the older formations. The marked tendency of the lava to decompose in this manner and to yield a rich soil of such a physical character that it absorbs and retains all of the rain which falls on it and is easily plowed, insures a long period of prosperity for this "Inland Empire," as the grain-growing region of eastern Oregon and Washington and neighboring portions of Idaho is sometimes termed.

The peculiar and interesting surface relief of the lava plateaus will be discussed further on, in connection with other features of the physiography of the region under consideration.

TRANSPORTED SOILS.

In addition to the residual soils in the Nez Perce region, which occupy probably ninety-nine one-hundredths of the surface, there are small detached areas, principally along the margins of the larger streams, where the soil is composed of silt, sand, and gravel deposited by the streams during high-water stages. These transported soils, in which the débris from an extensive series of cliffs is commingled, contain a great variety of rock fragments, usually well rounded and assorted and deposited in an orderly sequence with reference to size and specific gravity. At present this material forms flood plains which are inundated during high-water stages, or represents ancient flood plains which have been abandoned owing to the deepening of stream channels. In excavations in these deposits the changes to be observed as the depth below the surface increases, are such as are normal to similar accumulations the world over, and result from the manner in which the material was laid down. As a rule, the surface of a flood plain is composed of fine silt or fine sand; beneath this, at a depth usually varying from 3 to 4 feet, there is a change to gravel, and at lower levels pebbles, and even cobblestones and rounded water-worn bowlders, may be found. The reason for this arrangement is that the material in the flood plains of streams is continually being worked over by the streams themselves and becomes assorted. Where streams are depositing their loads they flow in curves, cut away their banks on the outer side, and make deposits on the inner side of each bend. The material cut away at one curve is carried downstream and much of it is redeposited on the inner side of the next curve below. This process is clearly illustrated along the lower course of Clearwater River, and can be observed in almost any brook or rill. The succession of finer and finer material from the bottom of a flood-plain deposit to the surface is due to the fact that the lower

portion is laid down in the central part of a stream, where the current is swift, and as the stream migrates finer and finer material is deposited upon it. The last layer is spread out during inundation. It also receives dust deposited from the air, is usually of fine quality, and forms a remarkably rich soil.[1]

Flood plains of the nature of those just described occur along Clearwater River, and are also well illustrated near Kamiah, Lewiston, Spalding, and Lapwai. They are built on deposits of the same nature, and in a few other instances, along the larger streams, there are small, nearly flat areas of a similar character; but in general the canyons are too narrow to permit the deposition of much of the material that is being transported through them. The streams in general are engaged in deepening their channels; they have not reached the stage of broadening their valleys and spreading out extensive flood plains. It is only where special conditions exist—for instance, the presence of soft beds at the level of the streams, as at Kamiah, or where a depression of the rocks has caused a widening of the valleys, as along Clearwater River near Lewiston—that flood plains of sufficient width to be of economic importance are to be found. The fact that the flat lands referred to are due to stream deposition is clearly shown in numerous instances by the presence of abandoned stream channels, some of which are in the condition of lakelets or sloughs.

Flood-plain deposits form the lands now under cultivation in Asotin Canyon, and there, as elsewhere, they are in danger of being removed by the same agency that built them. This obvious truth should be borne in mind by all who seek to cultivate the narrow flood plain in that canyon, particularly where the small, flat areas of rich land favorably situated for irrigation have tempted people to build their homes within reach of the creek when swollen by heavy rains. The canyon bears evidence of having recently been swept by floods caused by torrential rains, commonly termed cloudbursts. Similar high-water stages are sure to recur, and proper precautions should be taken to insure the safety of life, even if the risks to grain fields and orchards are accepted.

As will be shown further on, the rivers of the Nez Perce region first cut their canyons to about their present depths, then filled them with gravel to a depth of 350 feet, and have since removed the greater part of the material formerly deposited. In this process of reexcavation, in a few instances portions of old flood plains have been left, and they furnish examples of transported soils at a considerable elevation above the present streams. Clarkston is built on an alluvial deposit of this nature which has a sloping surface, owing to the fact that it is on the

[1] This and other important changes now being made by streams in the surface features of the earth are discussed somewhat fully in Rivers of North America, by Israel C. Russell, published by Putnam's Sons, New York, 1898.

concave side of a curve in Snake River, and the stream, in deepening its channel, migrated slowly eastward. In this instance there is a surface layer of fine silt-like material, about 5 or 6 feet thick, resting on coarse gravel and cobblestones. The surface layer furnishes a rich soil, and the open texture of the gravel beneath insures underdrainage, which prevents the concentration of alkali at the surface. This fortunate arrangement is favorable to the sanitary conditions, particularly as the water supply is brought from a distance.

Other areas of transported soil similar to that at Clarkston occur on the opposite side of Snake River and form the surface of the plateau on which the newer or upper portion of Lewiston is situated. Fine sections of flood-plain deposits are exposed in the margins of this plateau, especially where grades have been made along the streets connecting the upper with the lower portions of the city. Similar deposits occur near Alpowa, also in the canyon of Salmon River, near its mouth, and, of limited extent, along the borders of many small streams or where such streams enter the large canyons.

In connection with the examples of soils just cited, in which material has been brought from a distance, reference will be made to at least one somewhat conspicuous instance of wind transportation. Snake River just above Lewiston deposits on its right bank a considerable quantity of fine, white, micaceous sand or silt.[1] During low-water stages this material is exposed to the air, becomes dry, and is blown eastward by the prevailing winds. It is carried up the canyon wall, which there is low, over the sloping margin of the Lewiston Plateau for a distance of 2 or 3 miles, and is deposited largely in dunes, although much of it is widely distributed.

Some movement of the surface of the soil on even the generally level plateaus must result from the action of the wind, but in a state of nature, when the present extensive grain fields were prairies, the soil was held by plant roots and was sheltered by the vegetation growing

[1] Many of the sand bars along the borders of the larger streams in the Nez Perce region are of an exceptional character. The banks of the rivers are, as a rule, precipitous, so that gravel and sand can not be rolled along them under the influence of the current, but exceedingly fine sand, particularly flakes of mica, are carried in suspension by the swift water, and are deposited in eddies when the force of the current is slackened. Conspicuous bars or spits of white sand or silt are in certain instances formed in this manner, and are attached to the shore at their downstream extremities while their upper and usually rounded distal ends are free and are surrounded by water several feet deep. The explanation of the origin of these peculiar bars is that the fine material of which they are composed was brought down the streams in suspension by the strong central current, and when a portion of the water was deflected by changes in the direction of the shore line, an eddy was produced in which the water flowed upstream along the side of the channel. When the current slackened, on being deflected in this manner, the material in suspension was deposited and shaped into a bar or spit, with curved margins, the free end pointing upstream. A photograph of one of these spits of fine, white, micaceous silt is reproduced as Pl. VI, *A*.

The fineness and lightness of the silt forming these bars and the fact that it can be transported in suspension may be demonstrated by pushing a mass of it into the water and observing that a considerable portion of it will float, often being carried a long distance by even a gentle current before it finally sinks. Under natural conditions the bars are sometimes cut away during low-water stages and floating silt can be seen extending from them in all directions on its way down the stream. The material will float, however, only when its upper surface is dry, and in that condition it is perhaps buoyed up by air vesicles; but when wet it settles slowly, and in a rapid stream it will be carried long distances before finding a place sheltered from the current in which it can rest.

on them, so that the transfer, through this agency, of material from one locality to another must have been small in amount. At present, when so much of the fine soil is plowed and left for a season without being sown, and roads have been established, great quantities of dust are carried in the air during the summer season.

SUMMARY.

The deep soils and subsoils on the lava plateaus and also on the terraces formed by the projection of resistant layers in canyon walls where they are bordered by the Columbia River lava, have resulted from the disintegration and decay of the lava rock, and remain in their original positions or have been removed but short distances through the influence of beating rain, changes of temperature, the pull of gravity, etc. This widely extended surface sheet of decomposed rock furnishes a typical illustration of residual soil. While it has been formed principally from the lava rock, it contains some volcanic dust which was deposited on it and has been incorporated in it. This dust is richer in potash and soda than is the lava rock, and serves as a fertilizer. On the walls of canyons where terraces occur, and, what is equally common, where landslides have found terrace-like shelves, frequently with undrained basins on their surfaces, there is in many cases an admixture of volcanic dust, lapilli, gravel, sand, clay, etc., derived from layers of these substances which are interbedded with the lava sheets through which the canyons have been excavated. In a more critical classification than is here attempted these soils might be considered by themselves as representing colluvial deposits.

The soils on the foothills of the Bitterroot Mountains, and generally throughout the mountains as well as on the steptoes rising through the Columbia River lava, are also of sedentary origin, and have resulted from the disintegration and decay of the rocks on which they rest. The rocks forming these uplands yield to the influences of the atmosphere less readily than does the basalt of the adjacent plateaus, and furnish a soil that is less homogeneous and less thoroughly disintegrated.

No soils of glacial origin occur in the region represented on the map forming Pl. II. Transported soils occur in areas of limited extent along the rivers, and are principally the deposits of the rivers in recent times, although a few remnants of ancient flood plains still remain.

PHYSIOGRAPHY.

RELATION OF SURFACE RELIEF TO GEOLOGIC STRUCTURE AND CLIMATE.

As is well understood, the present diversity in the relief of all land areas is in the main the net result of two series of changes, or of the action of two agencies which are in opposition to each other. One of these embraces the movements in the earth's crust by which rocks are

raised above sea level, or, if originally above that horizon, are folded, tilted, etc.; while the other includes the denuding action of the atmosphere and of water, and has for its object, so to speak, the carving away of all land areas to sea level. In countries where the rainfall is small the changes in relief produced by upheaval, or, more definitely, the surface irregularities resulting from the folding and breaking (faulting) of the rocks and the tilting of areas of greater or less size bounded by folds or faults, remain prominent for a long period of time, and frequently furnish the most conspicuous features in the topography; while in humid lands, particularly where the climate is warm as well as humid and vegetation is luxuriant, rock decay is rapid, and the most conspicuous features in the relief of the land are likely to be such as result from denudation. Between these two extremes there are all degrees of gradation.

In the Nez Perce region the rainfall, as already stated, is small, but streams rising in the mountains to the eastward, where precipitation is heavy, flow across it, and conspicuous features in the relief are due both to movements in the underlying rocks and to stream erosion. For these reasons a knowledge of the structure of the rocks and of the manner in which streams have excavated channels in them is essential in order to understand the significance of the larger topographic features of the surface as it exists to-day. In fact, nearly the entire history of a region needs to be considered in order to be able fully to interpret its present relief.

ORIGINAL LAVA PLATEAU.

So far as the Nez Perce region is concerned, there seems to have been no conspicuous movements in the earth's crust during the time the Columbia River lava was being poured out. In other words, so far as known there are no unconformities in the lava sheets due to movements in one portion before the next succeeding sheet was spread out above it, although time intervals between successive sheets are in some instances recorded by sedimentary and other deposits. The edges of the lava sheets exposed in canyon walls are always essentially parallel with one another.[1]

A starting point in the study of the present relief is thus furnished by the condition of the surface at the time the last sheet of lava was spread over it. At the time referred to Nez Perce County and the country adjacent to the foothills of the Bitterroot Mountains was a featureless plain, diversified only by a few island-like peaks that rose through the lava. This plain, we are justified in assuming, was similar to the surfaces of many lava sheets of recent date which have been studied, and presented a rough and moderately uneven expanse of black, sco-

[1] An exception to this statement will perhaps be found in the northwestern portion of the Clarkston Plateau and in the region drained by Alpowa Creek.

riaceous, slag-like rock. That it was absolutely level is not to be supposed, since lava sheets may continue to flow after their surfaces have cooled and hardened, and the surface crust is frequently broken and perhaps forced up into ridges and hillocks. In a thick lava sheet shrinkage occurs after its surface has hardened, and the surface is deformed and frequently forced up into ridges or dome-like forms which crack open along their tops. For these and other reasons it is to be presumed that while the surface of the last sheet of Columbia River lava formed a plain without conspicuous inequalities, it was far from being smooth and even.

If we knew the elevation of the surface of the last sheet of lava as it existed before being deformed by movements in the earth's crust, much assistance would be gained in tracing the history of the present highly diversified topography. While a definite answer to this question can not at present be given, certain facts enable one to reach an approximate determination as to the original level of the lava plateau.

As already explained, the Columbia River lava was poured out in a molten condition, in a series of vast inundations, over a deeply eroded land surface. The contact of the lava with the formations on which it rests is always unconformable, and between the two there are no massive sediments. As the pile of lava sheets is in places more than 4,000 feet thick, it follows that the last sheet spread out must have had at least that elevation above the sea, unless the old land surface, like the region about the Dead Sea and the bottom of Death Valley at the present day, was below sea level, which is improbable. The only other escape from the conclusion just stated seems to be that movements producing a depression occurred during the time the lava sheets were being formed. If such a downward movement did occur, it was evidently not sufficient to carry the surface below sea level, for no marine sediments have been discovered between the lava sheets. Unconformities due to a folding or tilting of the earlier formed lava sheets before the succeeding sheets were spread out have not been discovered in the eastern portion of the formation under consideration, although such unconformities are known in the Cascade region. Whether the movements which caused the unconformity referred to influenced the eastern portion of the lava sheets can not at present be definitely stated.

From these considerations it might reasonably be expected that since the lava sheets in eastern Washington and Oregon and the adjacent portion of Idaho are still horizontal, the surface of the plateaus thus formed should have an elevation of at least 4,000 feet above the sea. Instead, however, we find in numerous instances that the general elevation of the plateaus underlain by essentially horizontal lava sheets is between 3,000 and 3,300 feet. This difference, approximately 1,000 feet, between the present elevation of the locally undisturbed plateaus and what is assumed to have been their original position can be

ascribed in part, perhaps, to erosion, but the amount of erosion is certainly small, and in places, as will be shown further on, it is nil, for the reason that portions of the scoriaceous surface of the last lava sheet have been protected by sedimentary beds laid down upon it, and these portions of the lava sheet have essentially the same elevation as the deeply weathered portions of the same sheet. A warrantable inference seems to be that there has been a general subsidence of the easttern portion of the Columbia River lava region referred to of at least 1,000 feet, which did not disturb the horizontality of the strata. This subsidence may have gone on during the time the lava was being extruded, or may have occurred in part or wholly since the last sheet of lava was spread out.[1]

LEADING FEATURES IN THE RELIEF DUE TO MOVEMENTS IN THE EARTH'S CRUST.

Whatever may have been the amount of the broad regional movements in the Nez Perce region, the fact that large areas have not been deformed but still remain essentially level and are underlain by horizontally bedded lava sheets, permits of reaching interesting conclusions

[1] The region occupied by the Columbia River lava is of special interest in reference to the study of the manner in which the earth's crust has been deformed, as it is unique and exceptional in the geologic history of North America. At the close of the eruptions which furnished the lava there existed in that region an essentially horizontal plateau 200,000 square miles or more in area, which in itself is exceptional in the history of topographic forms; but more than this, the plateau was produced by the outpouring of lava, and was built up, layer by layer, on a land surface. The plateau has since been variously deformed, but mostly in a broad way, and the nature of the movements can readily be determined. Moreover, the region is usually bare of trees, and the changes that have been made by erosion are sharply defined and easy to separate from those resulting from movements in the rocks. In the studies of isostasy and diastrophism that may be carried on there, the influence of the vast weight of the lava poured out at the surface, and also the withdrawal of a corresponding volume of liquid rock from beneath the surface, demand attention. The importance of the field as furnishing a test of isostasy is shown by the fact that the volume of the Columbia River lava is in the neighborhood of 50,000 to 60,000 cubic miles; its weight is about 160 pounds to the cubic foot; where the lava is 4,000 feet thick the pressure on the underlying rocks is in the neighborhood of 320 tons to the square foot. It is reasonable to suppose that the effect of the extrusion of so vast a volume of lava would be to cause a regional depression of the earth's crust. That this result was produced is shown by the fact that over the central part of the lava-covered country in Oregon and Washington the surface is now but a few hundred feet above sea level. At Pasco, Washington, the elevation is 386 feet, and over a large area of the surrounding lava plain the elevation is certainly less than 500 feet. The subsidence that has occurred in this region is not less than 3,500 feet, and probably exceeds that measure by at least 1,000 feet. This downward movement began, perhaps, at an early stage in the extrusion of the lava, and continued during the time the successive sheets were being spread out; but a part of the deformation which the lava has experienced, and possibly a part of the general subsidence of the central portion, has occurred since the extrusion of the last lava sheet. Other portions of the lava formation, of even greater extent than the central depressed region, have been upraised. In the Cascade Mountains the lava sheets, with a gentle eastward dip toward the depressed region, which includes the Great Plains of the Columbia, have an elevation of from 7,000 to 7,500 feet. The lava plateaus in eastern Oregon have an elevation of from 5,000 to 7,000 feet (Lindgren), and the general inclination of the beds, as in eastern Washington, is westward. Thus portions of both the eastern and western border of the lava-covered country have been raised from 3,000 to 3,500 feet, and the central part has been depressed by about the same amount from what would have been the surface level of the lava-covered country in case there was no subsidence during the extrusion of the lava. These movements have been in large part of the nature of a tilting of broad blocks of the lava, bounded by monoclinal folds and faults.

While the foregoing statements serve to indicate the general nature of the problems presented by the Columbia River lava, a detailed study will probably show that there have been extensive movements in the rocks during the time the lava was being poured out. For example, as has been shown by George Otis Smith, on the east side of the Cascade Mountains near Clealum, there is a strongly pronounced unconformity between a lower and an upper member of the lava formation, which proves that the lower portion of the pile of lava sheets was sharply folded and deeply eroded before the nearly horizontal and later sheets were poured out.

in reference to the movements that have affected adjacent areas where the strata are no longer horizontal. About the foothills of the Bitterroot Mountains there are many small valleys which still retain the level floors given them by the last inundation of Columbia River lava. These floors are horizontal, and beneath their coverings of alluvium their scoriaceous surfaces are to be seen. In several such instances the elevation of the lava surface is, by aneroid measurement, about 3,000 feet above the sea. This is also the general elevation of the Uniontown Plateau, to the north of Lewiston, beneath which the lava sheets are horizontal. The Uniontown Plateau, although its boundaries, except on the south, have not been defined, is certainly several hundred square miles in area, and extends, without any perceptible structural change in the rocks, eastward to the foothills of the Bitterroot Mountains, and on the northwest is believed to merge, without any conspicuous change, into the still more extensive region of similar character known as the Palouse country, where the lava sheets are also horizontal, or possibly have a slight dip to the westward, and where the general surface elevation is also about 3,000 feet. This extensive region of essentially horizontal lava sheets has evidently not undergone local deformation; and where adjacent areas beneath which the strata are inclined are below its level, it seems safe to conclude that they have been depressed; and where similar areas stand above the assumed datum plane, the conclusion is that they have been locally upraised. More definite reasons for assuming that the Uniontown Plateau may be taken as a datum plane for determining the amount of differential movements that has taken place in the adjacent plateaus, will, the writer thinks, be recognized in the somewhat detailed record of facts which follows.

The lava-covered portion of the region represented on the map forming Pl. II is divided naturally into six more or less well-defined areas of primary rank, which, when inclined, illustrate the nature of the movements which have affected the rocks beneath them. These areas are the Uniontown Plateau and the Camas and Kamiah prairies, beneath which the lava beds are horizontal, and the Blue Hills, the Lewiston and Clarkston plateaus, and Craig Mountain, beneath which the lava beds are inclined.

Uniontown Plateau.—Rising from the north or right bank of Clearwater River, throughout the lower 25 or 30 miles of its course and continuing westward beyond Lewiston, is a bold escarpment which in its central part has a height of about 2,000 feet. This is one of the most pronounced topographic features in Nez Perce County, and although in some respects it resembles the walls of the deeper portions of several of the great canyons in the same region, it is plainly of a different nature and origin. For example, there is but one escarpment, not two facing each other, as in the case of a canyon, except in a

minor way, as will be explained later. Then, too, the strata in the Clearwater escarpment, as it is convenient to term it, are for the most part not the edges of horizontal strata, as is commonly the case in the neighboring canyon walls, but are formed of inclined beds which dip southward. In the central and highest portion of the escarpment this southward dip is at a high angle, frequently 40 or 50 degrees, but near its extremities the inclination is more gentle. On climbing the escarpment it will be found to be the border of the nearly level Uniontown Plateau.

At the base of the Clearwater escarpment, and in general about 1,500 feet lower, are the Clarkston and Lewiston plateaus, described further on. The lava sheets, and certain sedimentary beds interstratified with them, which underlie the Uniontown Plateau, are horizontal, or essentially so; but in the Clearwater escarpment they bend abruptly downward, and at its base they flatten out beneath the Clarkston and Lewiston plateaus—that is, the escarpment is a monoclinal fold, which begins at the east, in the neighborhood of Agatha, as a gentle flexure, and increases both in height and in the inclination of the layers as one follows it westward, until near Lewiston its height is about 2,000 feet and the dip of the beds from 40 to 50 degrees. Still farther west, along

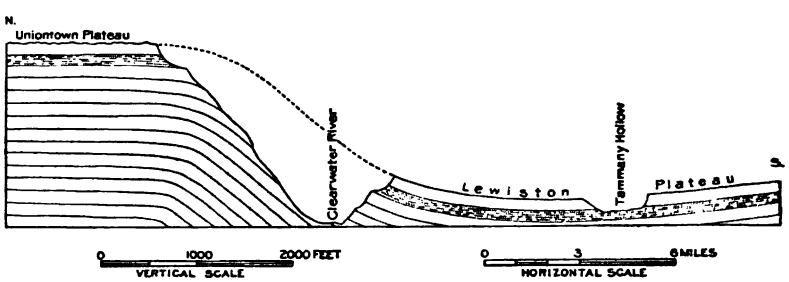

FIG. 1.—North-south section through the Uniontown Plateau, Clearwater escarpment, and Lewiston Plateau.

the north side of Snake River for 3 or 4 miles below Lewiston, the fold becomes a break or fault. How this fault terminates at the west is not known, but such facts as are in hand suggest that near Alpowa it passes again into a fold, which continues westward along the creek of the same name. The entire length of the fold, including the 2 or 3 miles where it is broken, is about 50 miles.

A peculiar and interesting fact in connection with the monoclinal fold just described is that Clearwater River flows directly along it for a distance of about 35 miles, and has excavated a canyon in it. The relation of the river to the fold is illustrated in fig. 1, which may be considered a generalized north-south section about 6 miles east of Lewiston.

At the locality referred to, and for a distance of about 10 miles upstream, the southward dip of the rocks forming the south side of Clearwater Valley is well shown. Again, to the west of Lewiston

Snake River enters this same monoclinal fold where it changes to a fault, and, bending westward at almost a right angle, continues in nearly the same course that the Clearwater has in the portion referred to above. From the abrupt bend made by Snake River just below Lewiston to the equally sharp curve made at Alpowa, the river flows along the monoclinal fold, in part a fault, which unites the Uniontown Plateau with the Clarkston Plateau. On the south side of Snake River between Lewiston and Alpowa, the southward dipping rocks form a conspicuous precipice facing north, in which a layer of columnar basalt is well exposed. The southward dip referred to may readily be seen from any commanding point near Lewiston. A north-south section midway between Lewiston and Alpowa would be similar to the one shown in fig. 1, but the southward dip on the south side of the river would be more pronounced.

The Uniontown Plateau is underlain all along its southern border, and apparently throughout practically its entire area, by horizontal sheets of basalt, which include at least one important bed of clay, sand, and gravel, at a depth of about 160 feet below the surface. The plateau is undulating, owing to stream erosion, as will be discussed further on, and at several localities on its southern border deep notches have been cut by streams flowing into Clearwater River.

Clarkston and Lewiston plateaus.—The country to the south of the Clearwater escarpment in the vicinity of Lewiston and Clarkston has been depressed about 2,000 feet below the level of the Uniontown Plateau, and the strata beneath it are inclined downward toward the north. This inclination is slight, however, but it affects the rocks for a distance of about 20 miles, so that its influence becomes conspicuous in the larger features of the surface relief. As the displacement producing the escarpment referred to dies out to both the east and the west, there is also an inclination of the beds beneath the sunken area and adjacent to the base of the Clearwater escarpment toward the center, where the movement was greatest. This center is at Lewiston-Clarkston, but the dip of the beds is too slight to be observed in rock outcrops, being only about 1,500 feet in a distance of 20 miles, although it is apparent in the surface slopes of the country.

Thus, the region to the south of the Clearwater escarpment has the form of a trough, with the axis running about north and south. This axis determined the general course taken by Snake River from the mouth of Grande Ronde River to Lewiston-Clarkston. Other movements also have affected the region. The rocks to the west of Snake River have a gentle inclination toward Lewiston-Clarkston over the broad area which is cut by the canyons of the various branches of Asotin Creek. This nearly level but deeply dissected country has been termed the Clarkston Plateau. The town for which it is named, however, is in the canyon of Snake River, about 500 feet below the general surface of the plateau.

On crossing the Clarkston Plateau from its eastern border along Snake River toward the southwest, the surface continues to rise until the plateau merges into the large dome-shaped uplift known as the Blue Hills. In this uplift the lava beds are carried about 2,000 feet higher than the surface of the Uniontown Plateau, showing that there has been a local uplifting of the lava sheets above their original position.

The country to the east of Snake River, for a distance of about 15 miles above Lewiston, has a gentle inclination toward that city, but it is roughened by stream erosion. This plateau, which has been termed the Lewiston Plateau, when crossed in a direction southeast from the town for which it is named, rises gently until the base of Craig Mountain is reached, where there is a steep ascent. The strata beneath the plateau correspond in dip with the surface slope of the broad areas between the stream-cut canyons, and at the border of Craig Mountain they are bent sharply upward. The latter mountain is formed by a monoclinal fold similar to the larger fold which determines the south border of the Uniontown Plateau, as will be described more fully further on.

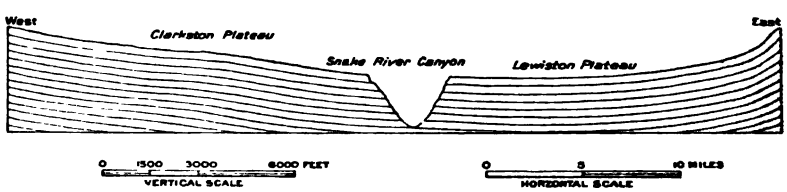

FIG. 2.—Section through the Lewiston and Clarkston plateaus.

The Clarkston and Lewiston plateaus are in reality a single topographic feature, but it is convenient to give them separate consideration, on account of the depth of Snake River Canyon, which has been excavated along the axis of the gentle north and south trough into which the rocks have been bent. Snake River, however, does not follow the axis of this trough precisely, but the northeastward slope of the rocks away from the Blue Hills extends east of the canyon, as can be seen in looking over the region from commanding points on the hills near Waha (Pl. VII), or from the summit of the Clearwater escarpment near Lewiston, and as indicated in the section shown in fig. 2. In the country on the east side of Snake River Canyon opposite Asotin, the axis of the synclinal trough formed by the junction of the strata which rise from it to the east and the west lies about 2 miles east of the course followed by the river.

It is important, in reference to the question of obtaining artesian water, to note that the surface slope of the broad remnants between the streams which have dissected the Lewiston and Clarkston plateaus, and also the inclination of the strata beneath the surface, is downward toward the towns for which the plateaus have been named.

LEWISTON PLATEAU FROM NEAR WAHA.

Blue Hills.—Included in part in the area represented on the map forming Pl. II are the Blue Hills, or mountains, as they are frequently termed, of southeastern Washington. This uplift was visited during the reconnaissance which forms the basis of this report, but the observations made give little information in addition to that contained in a previous publication.[1]

The Blue Hills have been elevated since the Columbia River lava of which they are composed was spread out in horizontal sheets. The uplift is of the nature of a broad, low dome, which attains an elevation of about 5,000 feet above the sea, or 2,000 feet above the level of the Uniontown Plateau. The strata which underlie the Clarkston Plateau, as has already been stated, rise gently toward the southwest, and pass, by insensible gradations, into the more steeply inclined portions of the same beds which have been elevated to form the Blue Hills. The differential movement which the once horizontal beds have experienced between Clarkston and the summit of the Blue Hills is about 4,000 feet. This change occurs in a distance, in a direct line, of 25 miles, but the upward movement at the southwest was sharper than the downward movement at the northeast. The strata involved in the Blue Hills uplift are inclined away from its summit portion in all directions, in essentially the same way that they are inclined to the northeast, where they pass into the Clarkston Plateau, but they dip somewhat more steeply on the south side than in other directions. The passage from the surrounding plateaus into the dome is so gentle that the eye can not distinguish where the change begins, but, in general terms, the uplift may be said to be from 50 to 60 miles in diameter from east to west, and to measure from 30 to 40 miles along its north-south axis. On the summit of the uplift the strata are so nearly horizontal that it is impracticable to measure their inclination, and on its sides the dip is seldom more than 2 or 3 degrees. If the uplift had not been eroded it would appear as a smooth dome, low in comparison with its width, but streams have sculptured it in a conspicuous manner, and its slopes are now trenched by deep canyons. The greatest change produced by erosion is on the south side, where Grande Ronde River has excavated a canyon comparable in grandeur with the finest portions of the neighboring Snake River Canyon.

Craig Mountain.—This name, although used somewhat indefinitely by the inhabitants of the Nez Perce region, will be considered as designating an elevation which extends in a northeast-southwest direction across the west-central portion of Nez Perce County, from the border of Snake River Canyon near Waha to the vicinity of Willola on Clearwater River. Viewed from the vicinity of Lewiston, the uplift appears to be a long, even-topped ridge, which begins at the northeast as a gentle swell and becomes higher and more precipitous as the eye follows it toward the southwest. On visiting the mountain,

[1] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4.

one finds it to be the upraised border of a broad plateau which is inclined to the southeast, but which soon flattens and forms the Camas and Kamiah prairies.

The northwest border of Craig Mountain is an escarpment of the same general character as the one forming the south border of the Uniontown Plateau, but it is less pronounced. It is a monoclinal fold which unites the Lewiston Plateau on the northeast with the Camas and Kamiah prairies on the southeast. It differs from the Clearwater escarpment, principally in the fact that the two plateaus which it unites slope away from its longer axis in each direction. A section through the Lewiston Plateau, Craig Mountain, and Camas Prairie would show the relations expressed in fig. 3.

Such a fold may, perhaps, be termed a gentle anticline, but as it unites two broad plateaus in which the strata are but gently inclined, it seems more accurate to designate it a monocline.

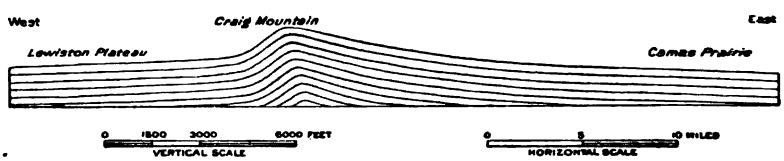

FIG. 3.—Section through Lewiston Plateau, Craig Mountain, and Camas Prairie.

At its northeastern extremity the Craig Mountain fold commences as a broad, gentle swell, and from this indefinite beginning it increases in height and steepness to the southwest until in the vicinity of Waha it is about 1,000 feet high and probably passes into a fault. In its higher portion, overlooking Snake River Canyon, Craig Mountain has an elevation of nearly 5,000 feet above the sea, and is densely forest covered. It is not a smooth plateau, but has been trenched by stream erosion. The most conspicuous change thus produced is in the case of Mission Creek, which has its source well to the southeast of the crest of the uplift, flows across it in a deep canyon, and continues, to its junction with Lapwai Creek, in a canyon cut in the Lewiston Plateau.

Camas and Kamiah prairies.—To the southeast of Craig Mountain lie the broad Camas and Kamiah prairies, beneath which the layers of Columbia River lava over an extensive area are nearly horizontal. This plateau measures about 40 miles in length from northeast to southwest, and is about 25 miles wide. The lava sheets beneath it, although horizontal throughout nearly its entire extent, are bent upward, as already stated, along its northwestern margin, to form the Craig Mountain monocline. The border of the sheets adjacent to the uplands of older rock on the south and east are also gently inclined upward from the great central area. Whether the rocks in this region form a complete basis remains to be determined by a study of the structure in the vicinity of Agatha. There the beds are nearly or quite horizontal.

and the Camas-Kamiah Plateau merges into the Uniontown Plateau, with little if any line of demarcation between, except such as has resulted from erosion. The general elevation of the broad central portion of this plateau is about 3,000 feet, and its surface is deeply trenched by various branches of Clearwater River.

Summary.—The deformation of the Nez Perce region since the outpouring of the Columbia River lava has been mainly in the direction of a tilting of the once horizontal lava sheets over broad areas. The movements have been greatest along certain lines where sharp folds have been produced which at times pass into faults, as the Clearwater and Craig escarpments. The most pronounced change has taken place in the Blue Hills, where a dome-shaped uplift has been raised. This so-called dome, however, is steepest on its southern side, and from another point of view may with propriety be considered of the same type as the Craig Mountain fold, but of larger size, and without a break in its steeper side.

The class of folds represented by the Blue Hills dome, Craig Mountain, and the Clearwater escarpment may be likened to waves and swells on the ocean; some are upswellings with nearly circular bases, others are elongated and have steep slopes on one side of the crest and a gentle descent on the opposite side, while in other instances the waves break, as when a monoclinal fold passes into a fault. There are also basins between the elevations, and extending through the waves and troughs alike are the deformed layers of once horizontal lava sheets. The elevations and depressions are so broad and the inclinations of the strata in general are so gentle, that the geologic terms in current use, derived principally from the study of sharply folded regions, can not be applied to them without conveying false impressions. The generalized type of the structural features may be considered as a monoclinal fold connecting two broad plateaus in which the strata are either horizontal or gently inclined. The greatest departure from this type occurs where the fold approaches a dome in shape, or where the steeper limb of a monocline is broken and becomes a fault.

LEADING FEATURES IN THE RELIEF DUE TO EROSION.

The Nez Perce region is characteristically a land of deep, steep-sided canyons with broad, generally level, remnants of the dissected plateaus between them. The canyons are naturally divided into two classes in reference to the origin of the streams that excavated them: (1) Those through which flow rivers the courses of which were determined before the deformation of the original lava plateau occurred, and are therefore to be classed as *antecedent streams;* and (2) the canyons cut by branches of the master streams, which in most instances had their courses determined by the slopes of the secondary plateaus and the monoclinal folds

which were produced by movements in the earth's crust, and which may therefore be termed *consequent streams.*

Magnificent examples of canyons produced by antecedent streams are furnished by Snake, Salmon, Clearwater, and Grande Ronde rivers. Each of these rivers flows through a profound canyon of its own making, but the height of the bordering walls varies from place to place in accordance with the movements in the direction of elevation or depression which have affected the country it crosses. Where plateaus or monoclinal folds have been boldly upraised athwart the course of a stream, its bordering walls are high and rugged; and where the rocks have been depressed the work of the stream has been less to establish a graded course to the sea, and its canyon becomes correspondingly shallow. In other words, the streams antedate the time when the plateaus were tilted or the monoclinal folds and faults came into existence, and have maintained their right of way as the country was deformed. The consequent streams represented by Asotin, Lapwai, Tammany, Lawyers, and many other creeks have had their courses determined by the slopes given to the various secondary plateaus into which the originally level lava sheets have been broken, and the depths of the canyons they have excavated have been determined by the depths of the great canyons cut by the master streams to which they are tributary.

Canyons of Snake River.—The head branches of Snake River are in southeastern Idaho and in neighboring portions of Wyoming, including the western part of the Yellowstone National Park. The river at first flows westward across southern Idaho for a distance of about 400 miles. It then bends sharply northward, and for a distance of 220 to 250 miles it follows the boundary between Idaho and the States of Oregon and Washington to Lewiston, where it again turns to the westward, and at Alpowa makes still another sharp bend, where it enters a steep-sided canyon cut in the Uniontown Plateau, and continues in a canyon to near its junction with the Columbia. The length of the river is in the neighborhood of 750 miles, and the part of its course to which attention is here invited is the northern portion of the central or northward-flowing section. Snake River is characteristically a canyon stream throughout nearly its entire length. The head of its canyon is now at Idaho Falls, in the southeastern part of Idaho, where its waters make a plunge of about 30 feet into a narrow trench in the basaltic rock. For a hundred miles above this cascade the main river and several of its branches flow over the surface of a vast lava flow, and instead of corrading their channels they are upgrading them by the deposition of alluvium brought from the mountains. Below Idaho Falls—practically all of the way to where it joins the Columbia—the river flows between precipitous walls from a few hundred to 4,000, and even 6,000, feet deep. From 30 to 60 miles south of Nez Perce County the river flows

SNAKE RIVER CANYON, SHOWING DETAILS IN WALL.

through an unusually rugged region known as the Seven Devils and Powder River (Eagle Creek) mountains, which are about 9,000 feet high and are mottled with snow throughout the summer. The combined canyon and mountain scenery is there perhaps the wildest and grandest in the Northwest, and rivals that of the finest portions of the justly celebrated Grand Canyon of the Colorado, except in brilliancy of color.

As is indicated on the accompanying map (Pl. II), Snake River follows the western boundary of Nez Perce County for from 40 to 50 miles. In this portion of its course it has excavated a canyon which may be divided into two well-defined sections of about equal length. Throughout the southern half of its course the river is in the bottom of a magnificent canyon with deeply sculptured walls 4,000 feet high and about 15 miles wide at the top. The rim rock at the crest of the walls on each side is formed by the edges of a lava sheet which immediately underlies the surface of Craig Mountain and of another similar plateau in Oregon. The northern half of the portion of the canyon referred to is narrow, being perhaps 2 miles wide at the top, and is cut in nearly horizontally bedded lava sheets; the walls, which are so steep that they appear vertical, are about 2,000 feet in height. This portion of the canyon has been excavated approximately along the axis of the trough between the Clarkston and Lewiston plateaus, which pitches to the northward, and the canyon walls decrease gradually in height as the lowest portion of these depressed plateaus is approached at Lewiston-Clarkston. The well-marked differences exhibited by these two sections of the canyon are due to the fact that in the southern section the rocks have been upraised and so profoundly dissected that the granite, limestone, etc., beneath the basalt is exposed and deeply trenched, while in the northern section the walls are entirely of basalt and the plateau through which the river flows has been depressed and the task of cutting a trench to a uniform gradient much lessened. These differences in the two sections of the canyon may be recognized by comparing Pls. IV and VI, *B*. The former is a view of the narrow, steep-sided canyon above Asotin, taken from a locality on its eastern border near Waha, and the latter is a view taken on the brink of the canyon in its deeper portion, on Craig Mountain opposite Mount Wilson, but the distances are so great that it fails to convey even a faint impression of the magnificence of the scene. Details of the walls of the canyon are shown in Pl. VIII.

Snake River Canyon in its deepest and wildest portion adjacent to Nez Perce County is joined by Salmon River Canyon, which comes in from the east and is of the same depth and character as the mighty trench excavated by the master stream. About 20 miles below the the mouth of Salmon River, Grande Ronde River joins Snake River from the west, and also flows through a magnificent canyon, scarcely

second in its scenic features to that of the larger river, and, like it, about 4,000 feet deep. Near its mouth Grande Ronde River is joined by Joseph Creek, which has also excavated a canyon as deep as the one it joins. These several strong streams, acting like endless saws, have cut into the great plateau which was elevated athwart their courses. Each of their branches has also striven to deepen its canyon at the same rate as the master stream, and the result is that a once even-surfaced and monotonous plateau has been given an exceedingly rugged topography.

The impression gained by one who follows the immediate borders of Snake River and its various branches would probably be that he is traversing a mountainous region; and this conclusion is true enough, for the land forms to be seen are far more rugged and lofty than the ridges and peaks of many greatly admired mountain ranges. It is only when a commanding summit is gained, like the top of Mount Wilson or the southern border of the Blue Hills, that the relations of the topographic features of an extensive portion of the rugged country are recognized, and it is seen to be a deeply dissected plateau. In far-reaching views large areas of the unmodified plateau surface are in sight, and the change from what is termed young topography to middle-aged and mature topography can be traced in different portions of the same upraised block of the earth's crust.

One not familiar with canyon scenery may perhaps fancy that the excavations made by streams in an elevated plateau are narrow trenches with vertical walls—in fact simply ravines of larger growth. While this is to some extent true of young canyons in homogeneous and resistant rocks, yet when the trenches become deep, especially if the rocks cut through are of varied character, the original narrow excavations are widened, especially at the top, and their walls are sculptured by lateral streams and are trenched by rills and brooks originating on them so as frequently to impart to them great diversity.

In the case of the canyon of Snake River from the mouth of Salmon River to near the locality where Grande Ronde River joins it, and again a few miles farther downstream, in the vicinity of Buffalo Rock, as has already been described, the Columbia River lava forms the upper portion of the canyon walls, while the lower slopes are cut in older and for the most part more resistant formations. The upper portions of the bordering walls, composed of basalt, have receded, and the canyon has been widened there more rapidly than in the lower portions, owing to the greater rapidity with which basalt weathers, in comparison with the formations on which it rests, and also on account of its longer exposure to the atmosphere; so that a broad canyon, with sculptured walls in which the exposed edges of the lava sheets are horizontal, has in its bottom a narrower canyon with precipitous and rugged sides. This canyon within a canyon is due entirely to differences in

the resistance of the rocks to weathering, and does not indicate movements in the earth's crust, as does a somewhat similar occurrence in the Grand Canyon of the Colorado.

Throughout the portion of the canyon where the rocks beneath the lava are exposed there is no flood plain and no land that is under cultivation. In the next section downstream, where only basalt occurs, although a true flood plain is lacking, there are small, moderately flat areas, composed in part of talus, which are irrigated by water derived from brooks which flow down steep side gulches, and orchards of peaches, apricots, pears, etc., are cultivated, producing a rich return of excellent fruit. The combined area of these detached fragments of flood plains that are under cultivation between the mouth of Asotin Creek and Grande Ronde River is only about 100 acres.

Downstream from where the last exposure of the terranes beneath the basalt is to be seen, the walls of the canyon are precipitous from base to summit, and although encumbered with débris are mostly grass covered. The character of the precipices is well shown in Pl. IV, in which the edges of the nearly horizontal lava sheets can readily be recognized. This portion of the canyon, as previously stated, is cut in general along the junction of the Lewiston and Clarkston plateaus, and the rocks are inclined downward toward the mouth. The walls of the canyon decrease in height as one approaches Lewiston-Clarkston, and at the same time its bottom becomes somewhat broader.

Just below Lewiston-Clarkston Snake River makes an abrupt bend to the westward. This sharp turn is due to the Clearwater escarpment, which runs at right angles to the previous course of the river and is about 2,000 feet high, with southward-dipping beds on its face which are inclined at angles of from 40 to 50 degrees or more. Evidently the escarpment was raised across the course of the river, or, more accurately, the plateau to the southward was depressed and the stream was turned aside. The river on turning to the westward follows the base of the great escarpment, but soon cuts into the fold which forms the escarpment, and flows along it for a distance of 5 or 6 miles, to Alpowa. There it makes another abrupt bend, and enters a narrow, steep-walled canyon cut in the Uniontown Plateau, similar to that shown in Pl. IV. The relation of Snake River to the monoclinal fold forming the Clearwater escarpment, in the portion of its course between Lewiston and Alpowa, is the same as exists in the case of Clearwater River. In fact, the portion of Snake River referred to is almost a direct continuation of Clearwater River, and flows along the same monoclinal fold, which there passes into a fault, leaving a large portion of the southward-dipping rocks on its southern or left border. The beds on the south side of the river dip southward at an angle of 6 to 7 degrees, but soon flatten and pass under the Clarkston Plateau, where they are nearly horizontal.

The variations in the depth of Snake River Canyon below the general level of the adjacent plateaus illustrate the relation of the river's work to the deformation which the rocks have undergone, and show that where the rocks have been lifted highest the trench cut by the river is deepest, and where the rocks have been depressed the walls of its canyon become low—at Lewiston-Clarkston they nearly disappear.

Snake River Canyon is typical of the class of larger canyons in the Nez Perce region, and to save space and avoid repetition the others need not be described at length.

Canyon of Grande Ronde River.—The country to the south of the Blue Hills is a high, deeply dissected plateau of the same general character as the neighboring region in which Snake River has excavated its magnificent canyon, except that the Columbia River lava there seems to be thicker, as the rocks beneath it are not exposed.

Grande Ronde River, Joseph Creek, and their various tributaries have excavated deep canyons, and the remnants of the original plateau have been reduced in width until in many instances they are sharp, serrate ridges. Everywhere throughout the rugged lands thus produced the edges of horizontal lava sheets are to be seen. In few places in the United States can better illustrations be found of the transformation, by stream erosion, of a level plateau underlain by a great thickness of horizontally bedded rocks into a region of excessively rugged topography. Near the junction of Joseph Creek with Grande Ronde River, and between the same creek and the canyon of Snake River, the topography is as rugged as it can be made with the present amount of uplift. Many of the ridges are sharp and along their crests are broken into pinnacles through the action of lateral rills and creeks, rain, frost, and wind. The continuation of the denudation, which has been long in progress, will tend to decrease the height of the multitude of ridges and peaks and to lessen the ruggedness of the relief. In short, the topography is mature and will slowly lose its salient features and flatten out so as to resemble its original monotonous character, unless renewed uplift occurs so as to allow the streams to cut more rapidly. Ascending the ridges between the various streams and traversing them toward the sources of the bordering canyons, they become broader and are easily recognized as portions of a vast, nearly level plateau. These broad surfaces are covered with a deep residual soil, as is common in all such instances in the Nez Perce region, and there probably has been some lowering of the general level, owing to rock decay and solution, but the amount is not known. In this connection, however, it should be remembered that the lava in changing to soil not only loses bulk, on account of the removal of the more soluble material, but may also gain in volume by reason of the change that takes place from a dense to a somewhat open texture, and also from the swelling of certain minerals because of a change to a hydrous condition.

One of the most instructive features in connection with the canyon of Grande Ronde River is the fact that the river cuts across the southern slope of the Blue Hills uplift, and there the lava sheets in each of its canyon walls dip southward. The explanation of this is that the river had its right of way established before the dome from which the present rugged relief of the Blue Hills has been produced by erosion was upraised. That is, as previously stated, the river is to be classed as an antecedent stream. The southward dip of the lava sheets in which the river in the portion of its course indicated on Pl. II has sunken its channel in an east-west direction has had a marked influence on the details of its bordering walls. On the north side of the canyon, where the lava sheets are inclined downward toward the river, there have been innumerable landslides; while on the south side, where the dip, although small, is away from the river, the bluffs in many places approach the vertical, and landslides are rare, except near the top, where occurs a bed of soft sedimentary material, which has caused a terrace to appear.[1]

Canyon of Salmon River.—At its mouth Salmon River is on a level with Snake River, into which it flows, but it is a rapid stream, throughout at least the lower 30 miles of its course, and has many swift, foaming rapids, but no actual cataracts. Where the two rivers unite there was, previous to the excavation of the profound canyons through which they now flow, about 2,000 feet in thickness of horizontal lava sheets resting on quartzite and dense igneous rocks. After cutting through the lava the streams found much more resistant rock below, and their canyons became narrow. The canyon of Salmon River for 5 or 6 miles upstream from its mouth is only wide enough for the roaring stream that rushes through it, and is quite impassable to man. Above this narrow portion, in excessively hard rock, the canyon widens, in basalt, and for about 20 miles, or to the mouth of Deer Creek, which comes in from the west, there is a narrow strip of flood plain on its western side and a series of terrace-like benches on the salients between the lateral streams; but the east wall is usually precipitous and possesses remarkably fine scenery. Beginning about 5 miles from its mouth and extending upstream 4 or 5 miles, Salmon River makes two sharp bends and passes about the base of a massive pile of basaltic rocks 2,500 feet high, which have been sculptured into castellated forms of remarkable grandeur. Here the basalt forms the bed of the stream, and on its immediate banks are exposed the summits of columns which show that the larger part of a thick sheet of lava still remains uncut. From this locality up to the summit of the remnants of the original plateau, which occur on all sides at a distance of from 5 to 15 or 20 miles, one finds only the edges of horizontal lava sheets. The portions of the original plateau remaining have surface elevations of more than 5,000 feet. The elevation at the mouth of Salmon River, according to surveys

[1] Other facts concerning Grande Ronde River and its branches will be found in a preceding report by the author—Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4 (1897), pp. 17, 25, 26.

made by the Oregon Railway and Navigation Company, is 965 feet, and the thickness of the lava is not less than 4,000 feet and may be considerably greater.

Upstream from the mouth of Deer Creek, Salmon River passes through two narrow gorges of dense igneous rocks, which project upward into the lava sheets; but between these obstructions the canyon widens, and has been excavated wholly in basalt. At the great bend of the river near Keuterville, the rocks beneath the lava again become prominent in the canyon walls, forming about half of their height, and the great gulf, about 3,500 feet deep, is nearly as impressive as the wildest portion of the canyon of Snake River. The same magnificent scenery continues far up the river above the big bend, but only distant views of it have been had by the writer.[1] Each of the creeks tributary to Salmon River below the big bend also flows in a deep canyon of its own making, so that the once widely extended plateau is nearly as deeply dissected and rugged as the similar region drained by Grande Ronde River.

The remnants of the elevated plateau adjacent to the lower course of Salmon River are clothed with coniferous forests, and trees grow here and there on the sides of its canyons; in a few instances yellow pines occur at the river's margin. The canyon walls, even where precipitous, are covered with bunch grass and afford fine pasturage.

Perhaps the most instructive physiographic feature of the river is the fact that for a distance of from 10 to 15 miles above the big bend it has cut its great canyon diagonally across a sloping plateau, and flows in a westerly direction, while the plateau dissected by it slopes northward, in conformity with the gentle inclination of the lava sheets beneath it. When followed northward the lava sheets flatten out and pass beneath the level surface of the Camas Prairie. A view of the lava sheets in the canyon is shown in Pl. V, *B*. The river crosses the sloping plateau in the great sweeping curve, but is sunk in a canyon about 3,500 feet deep. The relation of the course of the river to the slope of the plateau it crosses is shown in Pl. IX, *B*, and details of the canyon walls in Pl. X. Rock Creek, which rises on Mount Idaho and crosses a portion of the Camas Prairie, joins Salmon River after flowing through a deep, rugged gorge cut in the upraised border of the basin of the Camas Prairie; that is, it flows against the slope of the country and against the dip of the rock beneath it. The meaning of these facts is the same as in the case of Clearwater and Snake rivers, which have excavated canyons in the monoclinal fold joining the Uniontown Plateau with the Lewiston-Clarkston plateaus, and, again, in the case of Grande Ronde River, which cuts into the Blue Hills dome. In other words,

[1] An account of the upper portion of Salmon River Canyon, together with much information concerning the geology of the region traversed by it, will be found in the report by Waldemar Lindgren before cited, viz, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho, published in the Twentieth Annual Report of the U. S. Geological Survey, Part III, pp. 65-250

A. VALLEY OF SOUTH FORK OF CLEARWATER RIVER NEAR KAMIAH.

B. SALMON RIVER CANYON FROM COTTONWOOD BUTTE.

the rights of way of Salmon River and Rock Creek were established before the plateau formed by the last sheet of Columbia River lava was disturbed from its originally horizontal position.

Canyons of Clearwater River.—Clearwater River is formed by the union of many streams, the larger of which have their sources in the Bitterroot Mountains and flow westward. All of these branches, as well as the main river, flow in canyons, and in all cases where a stream passes from the region of diorite, schist, etc., into the Columbia River lava, a change in the character of the excavation it has made is at once manifest. In the older rocks the canyons are wide at the top and have less precipitous walls than where they have been cut in lava. The topography in the mountains consists of a labyrinth of sharp-crested ridges, with flaring valleys between, and the streams in the valley are swift and without flood plains. The character of the country is indicated to some extent by the fact that the trails follow the crests of the ridges persistently, there being no room for them adjacent to the streams. On entering the lava-covered region the streams are bounded by more precipitous walls, and where they have not cut through the lava their sides frequently approach the vertical, from base to summit. Some of the creeks from the mountains flow for a mile or more over the basalt, as surface streams, before plunging into a narrow canyon at its head. Between the canyons cut in the lava there are broad, nearly flat remnants of the once widely extended and undissected plateau. These differences may be briefly summarized by stating that in the rocks older than the Columbia River lava the topography is mature, but in the region floored by the lava it is young.

The particular feature in the physiography of the region drained by Clearwater River which is of greatest interest is the relation of the lower portion of the trunk stream to the monoclinal fold which unites the Uniontown Plateau with the Lewiston-Clarkston plateaus. In the portion of its course referred to Clearwater River flows directly along a monoclinal fold, in what may be termed, under a classification of valleys once proposed by J. W. Powell,[1] a monoclinal valley; that is, the rocks in each wall of the valley, as well as beneath its floor, dip in one direction, namely, southward.

On the south side of the valley the rocks are inclined upward, from the position they occupy beneath the Lewiston Plateau, at an angle of perhaps 1 or 2 degrees in the vicinity of Myrtle, which increases westward to the great escarpment overlooking Lewiston, where it is 40 to 50 degrees. Throughout this distance the crest line of the north wall of the valley is nearly level, although rendered irregular by the presence of gulches with salients between; but the south wall, which at the east is about on a level with its companion to the north, gradually declines, and at Lewiston it nearly disappears. The south wall is com-

[1] Exploration of the Colorado River of the West. Washington, 1875, p. 160.

posed of lava sheets which dip southward but soon flatten and pass under the more nearly level Lewiston Plateau, thus forming an elevated rim along the side of Clearwater River Valley. This peculiar feature of a large river apparently excavating a canyon along a steeply sloping mountain side, instead of descending to the adjacent valley, can be explained only on the hypothesis that the course of the river was established before movements in the earth's crust formed the monoclinal fold which it follows. The river has deepened its channel as the rocks beneath it were bent.

The relation of Clearwater River to the fold it follows suggests that before the lava sheets were flexed the river had cut in them a trench sufficiently deep to determine a line of weakness along which a sharp fold was produced when subsequent movement occurred. The greater part of the canyon cutting, however, was after the monoclinal fold was initiated.[1]

RELATION OF THE STREAMS TO GEOLOGIC STRUCTURE.

In the brief account of the canyons of the Nez Perce region which has just been given, references have been made to the manner in which the larger streams cross sloping surfaces diagonally, as in the case of Grande Ronde River, which cuts into the southern portion of the Blue Hills dome, and Salmon River, which sweeps in a great curve into the upraised border of the Camas Prairie but leaves that topographic basin without reaching its lower portion; and also to the fact that Snake River has cut through the Craig Mountain uplift, and again, at the depressed northern border of the Lewiston-Clarkston plateaus, on which its valley broadens and is only about 200 feet deep, it enters a canyon 2,000 feet deep in the Uniontown Plateau. In this same category is to be placed the fact that Clearwater River in its lower course, and Snake River between Lewiston and Alpowa, flow directly along a monoclinal fold in monoclinal valleys.

The important group of observations just summarized shows that the courses of the streams referred to are to a great extent independent of the structure of the rocks in which they have excavated their canyons, and are also equally independent of the larger features in the surface relief, since the inclination of the various plateaus, which are the major physiographic elements, corresponds with the dip of the underlying lava sheets. In order to make this conclusion clearer and more graphic, let us trace in outline the chapter in the history of the Nez Perce region to be read in surface geology and drainage system.

[1] In this connection the idea presents itself that if a broad plateau underlain by horizontally bedded rocks of the nature of, especially, lava sheets, which may be considered as being resistant to deformation by bending, should have a canyon cut in its surface, such a canyon, especially if long and straight, would mark out a line of weakness which would determine where maximum deformation would occur in case the beds should be warped or displaced by a tangential thrust acting at right angles to the course of the canyon; that is, in some instances streams are not only antecedent to structure, but they exert an influence on the structure itself. While the facts in hand do not warrant the unqualified acceptance of this view, they at least awaken a desire to test it by more extended observations.

SALMON RIVER CANYON, SHOWING DETAILS IN WALL.

When the last sheet of Columbia River lava was poured out it formed the surface of a nearly level plateau to the westward of the Bitterroot Mountains, across which the streams from the eastward, such as Snake, Salmon, and Clearwater rivers, had to flow in order to deliver their waters to the ocean. It is probable that lakes were formed on the lava plateau, but this and other phases of the history need not concern us at present. The rivers in time excavated canyons which were deepest near their mouths and were slowly extended upstream. After this work was well under way in the immediate region here considered, movements in the rocks began, which continued for a long time, and perhaps have not yet ceased. These movements produced a deformation of the originally level surface, of the nature of a tilting of broad blocks of the original plateau. These blocks experienced differential movement in reference to one another, and along their borders were in certain instances bent into monoclinal folds, and where the flexures were sharpest breaks occurred. The differential movements of the various blocks went on so slowly in most instances that where the rivers crossed the belts of flexure they were able to deepen or upgrade their channels as rapidly as the surface was deformed. Where the border of a tilted block rose athwart the course of a river a canyon was cut across it, as in the case of Snake River where it crosses the Craig Mountain uplift. In some cases, however, the deformation went on more rapidly than the river could deepen or upgrade its channel, and the stream was turned aside. An illustration of this is furnished by Grande Ronde River, which was turned from the course it has in its upstream portion by the elevation of the Blue Hills dome. The best example of the raising of a wall directly athwart the course of a river, and that, too, the largest river of the region, is furnished by the Clearwater escarpment, which turned Snake River aside at the site of Lewiston. This escarpment, which it will be remembered is the southern border of the nearly level Uniontown Plateau, was formed directly across the course of Snake River, and the maximum displacement occurred at the locality where the river crossed its site. For a portion of the way between Lewiston and Alpowa the Clearwater escarpment, which elsewhere is a monoclinal fold, became a fault. The break here occurred 2 or 3 miles west of Lewiston; but directly in the course of Snake River to the north of Lewiston the rocks in the face of the escarpment as it exists to-day dip southward at angles of from 30 to 50 degrees. The differential movement between the borders of the Uniontown Plateau and the Lewiston-Clarkston plateaus occurred with sufficient rapidity to deflect the river and cause it to flow westward along the break produced by faulting until it could pass about the end of the portion of the belt of disturbance where the movement was greatest. An irregular course was thus established, which the stream was able to maintain as the tilting and depression of the Lewiston-Clarkston plateaus went on. It is possible that Snake River was checked

by an uprising of the Clearwater escarpment, and a lobe was formed. That such was the case, however, has not been clearly proved, although certain silt-like deposits on the Clarkston Plateau may have been laid down in such a water body. The deposits referred to have not been carefully examined.

As the deformation of the original lava plateau progressed and the larger streams deepened their channels, their tributaries, situated on rocks that were but slightly disturbed, or strong enough to maintain their rights of way where the movements were greatest, also deepened their channels, owing to the greater velocity given them by the lowering of the master streams into which they discharged and likewise excavated canyons. Most of the smaller streams, however, came into existence after the deformation of the surface was initiated, and were guided by the slopes produced. For example, all of the streams which flow from the Blue Hills to Snake River have courses such as would be determined by the present slope of the surface. These streams, and probably all others flowing away from the Blue Hills, came into existence after that region was upraised into a dome. In a similar way, all of the streams in the central portion of Nez Perce County, which enter either the Snake, the Salmon, or Clearwater River, flow through channels such as would be determined by the inclinations of the present surface and the depth of the master streams to which they are tributary.

The streams of the Nez Perce region may therefore be classed in two groups, in reference to the relation they bear to the structure of the rocks over which they flow: (1) Streams the courses of which were established before the underlying rocks were disturbed from their original horizontal positions, and which may be classed with what geographers term antecedent streams, of which Snake, Grande Ronde, Salmon, and Clearwater rivers are the leading if not the only examples; and (2) streams which came into existence on the slopes produced by deformation, and which are consequent to them and therefore are termed consequent streams, many examples of which might be named, as, for instance, Asotin Creek and its several branches, Lapwai Creek and its principal tributaries, Cottonwood, Lawyers, Little Canyon, and other creeks which drain broad portions of the deformed lava-covered country and are consequent on slopes produced by deformation. There is still another and subordinate class of streams, such as flow down the steep canyon walls, which are consequent on slopes due to erosion.

STREAM TERRACES.

In a previous report[1] the writer has directed attention to the widely distributed and frequently thick gravel desposits in the canyons of both the Cascade and the Rocky Mountain ranges in Washington and

[1] A preliminary paper on the geology of the Cascade Mountains in northern Washington, by I. C. Russell: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 173-184.

Idaho, which were formed after the rivers had excavated their channels to their present depth, but have since been reexcavated, so that in many instances only small remnants of them now remain. Several examples of these gravel deposits belonging to the Pleistocene division of geologic history occur in the Nez Perce region.

Remnants of former flood plains of Snake and Clearwater rivers occur in Lewiston and Clarkston, and may there be studied to advantage. In Lewiston sections of heavy stream-laid gravel are admirably exposed in the bluff which separates the lower portion of the city, which is built principally on the present flood plain of Clearwater River, from an old flood plain, at an elevation of 150 feet above the low-water stage of Snake River, on which the newer portion of the city is situated. The plateau referred to is an abandoned flood plain, and shows that the rivers now flowing past its base at some former period filled their channels from side to side, so as to elevate their beds at least 150 feet above their present summer levels. The plateau on which the newer portion of the city is located is triangular in shape, a mile or more broad, and on its margins facing Snake and Clearwater rivers instructive sections can be seen of the well-worn bowlders, cobblestones, gravel, and sand of which it is composed. As in the case of many flood plains, the last material deposited is a fine sand or silt. On the southern side of the plateau, where it joins the uplands at what was formerly the junction of Snake and Clearwater rivers, there are still higher gravel deposits of the same character, showing that the most conspicuous terrace now remaining was excavated in a higher flood plain, the upper limit of which is indefinite.

At the mouth of Tammany Hollow, nearly opposite Asotin, there is a well-defined gravel bar, built by Snake River, which crosses the mouth of the lateral canyon and at one time formed a dam which caused the waters of Tammany Creek to expand and form a small lake. This bar is, by aneroid measurement, 235 feet above the summer stage of Snake River. Since Snake River cleared out the greater part of its former gravel deposits, Tammany Creek has cut a narrow channel through the obstruction at the mouth of its canyon. The bar referred to, and others similar to it along the course of Snake River, shows that the main stream was at one time overloaded with débris, a large part of which was deposited in its channel, while its small tributaries were not thus loaded and could not fill in their valleys so as to elevate their bottoms at the same rate as did the master stream to which they flowed. The result was that the weak lateral streams were ponded and expanded into lakes. In a similar way lateral canyons which were perhaps without perennial streams were flooded, owing to the expansion of the main stream and the gravel carried into them.

The broad, sloping gravel plain on which Clarkston stands is similar to the gravel plateau in Lewiston, but occupies a less sheltered posi-

tion in reference to Snake River, and was cut away to a considerable extent as the river deepened its channel after the period of overloading had passed. The gravel beneath Clarkston is situated on the inner or convex side of a river curve, and was left with a sloping surface as the stream migrated eastward. A similar sloping surface covered with fine silt can be seen on the inner curves of many small streams which now meander through nearly level-floored valleys.

Another remnant of the once extensive alluvial deposits along Snake River occurs just above Alpowa, forming a flat-topped terrace 150 feet above its present summer stage. Again, in the canyon of Salmon River, about 5 miles above its mouth, there are, on each side of the canyon, terraces composed of a large variety of well-worn pebbles, which have a surface elevation of 230 feet above the present level of the rivers.

The extreme upper limit of the gravel deposited in the canyon of Snake River, as determined by aneroid measurements, was stated in a previous report[1] to be 360 feet above the low-water stage of the river as it flows at present. This measure is perhaps too liberal, and may have to be reduced. The principal difficulty in determining the exact upper limit of the gravel lies in the fact that it is usually indefinite, and in some places is difficult to discriminate from the gravel derived from sedimentary beds interstratified with the Columbia River lava.

The remnants of the old gravel flood plains just described, taken in connection with similar facts observed over a wide extent of country in Idaho and Washington, furnish clear evidence that the larger canyons of the Nez Perce region, after being excavated to their present depth, were deeply filled with gravel and subsequently were reexcavated. During the last down-cutting remnants of the former flood plains were left in sheltered places, as on the inner sides of sharp bends and at the mouths of small lateral canyons. The changes in conditions which permitted the strong rivers to excavate canyons in the Columbia River lava to a depth of from 2,000 to 4,000 feet, then deposit in them gravel to a depth of at least 230 feet, probably 360 feet, and subsequently reexcavate them and renew the task of deepening the channels in the solid lava, seems to have been principally the overloading of the streams at a certain period in their history. For a long time the swift rivers rising in the mountains were able to carry their loads to the sea or to the larger rivers to which they were tributary, and the friction of the débris thus transported deepened their channels. Next came a period when the rivers had more débris delivered to them in their high-grade, and consequently swift, upper courses than they could transport through their long canyons, and some of it was dropped, thus raising the stream bed and permitting

[1] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4, pp. 56-57.

the water to flow more rapidly. After a time the overloading ceased, and the streams, with added energy, owing to the higher gradients produced by the partial filling of their channels, were enabled to remove the débris previously deposited. This work has gone on until nearly all of the gravel, sand, etc., formerly laid aside has been carried away, and the rivers in places are down to their beds of solid rock; but in general, as can be seen in Clearwater and Snake rivers for a distance of several miles from their junction, they are still floored with coarse gravel. During high-water stages immense quantities of this bottom load are moved downstream, to such an extent in the case of Clearwater River as to show the futility of attempting to deepen that river in order to make it navigable.

The causes which led to the overloading of the rivers flowing from the mountains of Washington, Idaho, etc., during a certain period in their history, have been discussed in the previous report referred to, and can not be considered at length here. It will suffice to say that the main reason seems to have been the climatic change which brought on the Glacial epoch. Precipitation is thought to have increased at that time beyond what it was before or has been since; the mean annual temperature was lowered, and glaciers existed in the mountains. These agencies would tend to increase the loads brought by swift tributaries to the trunk streams, but would also increase the volumes of the rivers and consequently their velocities and power to transport. If the increase in load, however, was in a greater ratio than the increase in transporting power, the stream beds would be upgraded; and, according to the best interpretation of the facts that can now be made, this seems to have been the case.

LANDSLIDE TOPOGRAPHY.

Rock masses which have descended as landslides form so important a feature of the canyon walls in the Nez Perce region and have so intimate a connection with the search for lignite deposits and the question of water supply, that their nature needs to be well understood.

The distinctions between landslides, displaced rock masses, rock avalanches, mud flows, snow avalanches, etc., have been pointed out in previous reports,[1] and seemingly but little needs to be said at present in this connection, except what applies directly to the region under consideration.

A landslide is understood to be the breaking away of one or more large blocks of rock, or of a quantity of loose material, from a slope,

[1] A geological reconnoissance in central Washington, by I. C. Russell: Bull. U. S. Geol. Survey No. 108, pp. 47–49, Pls. III, IV, and V.

Topographic features due to landslides, by I. C. Russell: Pop. Sci. Monthly, Vol. LIII, Aug., 1898, pp. 480–489.

A preliminary paper on the geology of the Cascade Mountains in northern Washington, by I. C. Russell: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 193–200.

and its quick descent into an adjacent depression. The landslides in the Nez Perce region, so far as noted, are confined to the walls of canyons in the Columbia River lava. The most favorable conditions for their occurrence are where canyons have been cut in thick sheets of lava, especially where the lava is traversed by vertical joints so as to be columnar, and rests on beds of clay, sand, gravel, volcanic dust, lapilli, etc. These conditions are rendered still more favorable when a series of lava sheets with included layers of soft material are inclined toward the stream which has excavated a canyon in them. Under such circumstances, blocks of lava are likely to break away from the cliffs and to descend the slope below, perhaps even reach the stream at its base. Where a landslide comes to rest, it is usually found that the surface of the fallen block or of the mass of loose material which has descended has a slope toward the cliff from which it fell. This backward slope is frequently so pronounced that basins are formed, which under favorable climatic conditions become swamps or lakes, but in dry regions are more frequently grassy hollows, or perhaps are overgrown with bushes and trees while the drier slopes adjacent are bare. From recent landslides which retain their characteristic forms unimpaired there are in many regions, as has been described in the reports just cited, illustrations of a complete series of gradations to areas which are nearly level although having a somewhat undulating topography produced by the weathering of ancient landslides. Thus there is a series of changes in relief, due to landslides, which may be included under the term *landslide topography*. Prefixes denoting age might be used in connection with this term, to indicate the extent to which the fallen masses have yielded to weathering and erosion.

In the Nez Perce region landslides have occurred on the sides of all of the larger and many of the smaller canyons excavated in the Columbia River lava, in places frequently a score or more of miles in length, and on each side of a stream they can be counted by the hundreds in a single mile. Only a few of these many localities, however, can be referred to in this paper.

On the north side of Grande Ronde River where it cuts into the Blue Hills uplift, the conditions are unusually favorable for landslides, as the lava sheets are inclined downward toward the river and have beds of sand, clay, lignite, and volcanic dust interbedded with them. Over extensive areas, measuring in fact many square miles, the canyon wall is encumbered by heaps and ridges of material which has descended from above. From the river's bank to the rim rock which defines the border of the canyon at the top of the Blue Hills, a distance of 7 or 8 miles, there is, except on the salients, a succession of fallen blocks, some of them at least a half mile in length, which frequently have undrained basins on their gently sloping northern sides. The characteristics of young landslide topography are there well displayed, although most of the fallen masses have been in their present

position long enough to be covered with a deep soil, except on the precipitous southern slopes, and are overgrown with magnificent forest trees. On the south side of the canyon the precipices are steep, in places nearly vertical for 2,000 feet above the river, and landslides are rare. The reason for this is that the lava sheets dip to the southward, or away from the river, and the tendency for blocks to fall is far less than on the opposite wall of the canyon. Near the summit of the southern wall there is a bed of soft material, reported to contain lignite, underlying the summit sheet of lava. This sheet of soft material has caused the border of the lava layer above it to recede more rapidly than the margins of the layer beneath, and a terrace has resulted, which in many places has on its surface landslides and conspicuous talus slopes.

In the walls of the canyon of Snake River the lava sheets are nearly horizontal, so far, at least, as a slope toward or from the river is concerned, and landslides are rare. So far as known there is but one bed of sedimentary material between the lava sheets that have been cut by Snake River. If two such soft beds are present, as is the case on Asotin Creek, they influence the topography in essentially the same way that a single sheet would, and for that reason the conditions are unfavorable for the development of characteristic landslide topography on a large scale. As previously stated, the sheet of soft material is at a depth of 200 to 220 feet, and, as on the south side of Grande Ronde River, has given origin to a terrace, which may be traced for a score or more of miles along the walls of the canyon below the mouth of Grande Ronde River and into many of the smaller tributary canyons and gulches. This terrace is almost everywhere deeply covered with fallen débris, and frequently exhibits the characteristic features of landslide topography. A typical example of the conditions just referred to can be seen on the east side of Snake River between Lewiston and the mouth of Tammany Hollow, where the dip of the lava sheets beneath the Lewiston and Clarkston plateaus brings the soft layer which gives rise to the landslides down to within a few hundred feet of the level of the river. On the opposite side of the river is Swallow Rock, a displaced block of lava of unusually large size and massiveness, the surface of which slopes steeply downward toward the cliff from which it broke away.

Landslides are abundant throughout the course of Clearwater River and its principal tributaries where they have cut canyons in the lava, and are especially numerous in the vicinity of Kamiah, where they impress their peculiar features on the scenery of the bluffs, which for several miles face the river on each side. The lava sheets are there nearly horizontal, but at a depth of about 800 feet, and contain an unusually thick layer of friable sandstone which has caused almost innumerable landslides. The exceptional breadth of this portion of the canyon, which is a beautiful vale 2 or 3 miles wide, with pleasingly

diversified, tree-clothed bordering bluffs 1,800 feet high, is due to the widening of the once narrow gorge by the falling of its walls. The irregularities which landslides give to the escarpments, and the subdued effect of their slopes from the same cause, are illustrated in Pl. IX, *A*, a view of the eastern side of Kamiah Vale near the village from which it derives its name.

In the description on page 39, of the occurrence of lignite and its associated sedimentary beds near Orofino and along the creek of the same name, mention was made of the numerous displaced rock masses in that region. The borders of the canyon of Orofino Creek not only owe the minor features of their topography to landslides, but the character of the entire canyon has been modified by them. There is an outer canyon, bordered by cliffs and steep talus slopes, from 700 to 800 feet high. At the base of these rugged walls, in which the edges of horizontal sheets of lava appear, there is, on each side of the creek, an irregular terrace-like belt a mile or more wide, the surface of which shows the ridges, hills, and basins characteristic of landslide topography. This broken country is from 400 to 500 feet above the stream which flows through it in a steep-sided inner canyon. At a few localities the landslides have obstructed the river and caused it to flow swiftly through narrow defiles. In one of these rapids, about 6 miles from the mouth of the creek, the water descends 92 feet in a distance of about 500 feet.

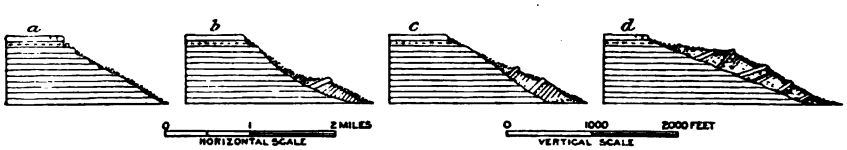

FIG. 4.—Sections of cliffs with landslides.

On the North Fork of Clearwater River, opposite the mouth of Elk Creek, the canyon wall exhibits the characteristic feature that landslides give to precipitous escarpments, and the cause of the numerous slides is revealed by the presence of sand and lignite in the fallen masses. It is stated that at this locality some movement in the displaced blocks near the river has been recognized in recent years.

It is perhaps unnecessary to attempt to give additional examples of the changes produced in canyons by the falling of their walls, for they are so numerous that once the meaning of the ridges and basins so common on steep slopes is suggested a person can readily interpret them for himself. The manner in which the faces of cliffs break away and the displaced masses descend the slopes below is illustrated in a general way in fig. 4. At *a* the nature of the canyon walls where not modified by landslides is indicated, the stratification being horizontal and the lava sheets separated in a single instance by a sedimentary bed: at *b* a single block has fallen; at *c* two slides have descended; and at *d*

an attempt has been made to indicate roughly the nature of the canyon walls where many slides have occurred and where much loose material encumbers the slope. The last figure (*d*) illustrates in a rude way the condition of the precipitous slope throughout the greater part of the lava-covered portion of the Nez Perce region. The most noticeable feature in a landslide that has come to rest is the slope of the surface of the fallen mass toward the cliff from which it broke away. This characteristic backward slope is pronounced not only in solid blocks which still retain their stratification, but in masses of dislodged fragments, and it gives origin to basins which, as already noted, are frequently transformed into lakes and swamps.

The back slope in the landslides in the Columbia River lava is frequently from 3 to 5 degrees, but may reach 20 or more degrees. This peculiar feature seems to be due to the fact that the friction of the sliding mass causes its forward portion at the base to be retarded so that it is overridden by the material in its rear. Where the base of the displaced portion is of soft material it is pressed outward to the front of the descending mass and is sheared and overthrust so as to become thickened. For this reason the thickness of the soft layers in the fallen masses is deceptive and might lead to erroneous conclusions regarding, for instance, the importance of a lignite bed.

The general reason that landslides are more frequent and usually of larger size on Clearwater River and its main tributaries than along Snake River is that the soft beds to which the landslides are largely due are thicker and more numerous the nearer one approaches the mountains from which the streams brought débris and deposited it on the Columbia River lava. The beds of water-laid débris are of the nature of wedges, which are not only most numerous but thickest and coarsest at the margin of the lava-covered country adjacent to uplands, and thin out and become finer as its central region is approached. These stream-laid deposits may merge with lacustral sediments, in which event other conditions favoring landslides would result. In addition to the presence of beds of soft material between the lava sheets, conditions favoring the occurrence of landslides are produced, as already explained, where the sheets have been tilted.

So constant is the relation between landslides and the presence of sedimentary beds or sheets of volcanic dust and lapilli in the Columbia River lava, particularly where the sheets are horizontal, that the landslides furnish an indication of the extent and thickness of the soft layers.

LAKE WAHA.

The only water body in the Nez Perce region worthy to be termed a lake is 18 miles, in a direct line, southeast of Lewiston and at the base of the northeastward-facing escarpment of Craig Mountain. The lake is not only an exceptional feature in the deeply sculptured land where

it occurs, but it is surrounded by attractive scenery and is charming in many ways. It occupies a steep-sided valley eroded by Waha Creek, which has been obstructed by landslides and has an area, as determined by surveys made by Mr. E. H. Libby, president and general manager of the Lewiston Water and Power Company, of approximately 100 acres, and a maximum depth of 90 feet; the average depth is about 60 feet. It has no surface outlet, but its waters escape through the great mass of broken stones which retain it and comes to the surface in springs of large volume. The main landslide which obstructs the valley came from the precipitous slope, now covered with forest, to the southwest of the northern border of the lake, and still presents the characteristics of what may be termed a landslide scar. At the base of this steep slope there is a narrow, curving, trench-like depression, convex to the north, on which side it is bordered by the back slope of the mass that fell. This trench has an irregular bottom; and although it is probably at no point more than 20 feet above the lake's surface, and is open at both ends, it never was occupied as a channel of discharge for the lake waters. The surface of the fallen mass, which occupies perhaps 30 to 40 acres, is irregular and hilly, with elevations that rise from 100 to 150 feet above the lake's surface. It contains several basins, two of which are occupied by ponds fed by springs and by percolation. Middle Lake, about 1 acre in area, is, by aneroid measurement, 20 feet lower than Lake Waha; the lowest point on its rim, where a wagon road now traverses it, is 60 feet above its surface and 200 feet above the surface of Mud Lake, which occupies an adjoining basin. The last-named lake has an estimated area of 2 acres, and, like its companion, is without surface outlet.

The lava sheets which form the steep slope of Craig Mountain in the vicinity of Waha dip northward at a steep angle, and have at least one bed of gravel interstratified with them. The presence of a bed of volcanic dust or of clay charged with that material, although nowhere exposed, is indicated by the color of the water in the largest lake. A peculiarity of springs that come from beds of volcanic dust is that their waters are milky or opalescent in appearance, due to the excessively small particles of volcanic glass held in suspension. The waters of Lake Waha have this appearance, and probably are supplied in part by springs issuing from deposits of volcanic dust. The dip of the lava sheets in the escarpment rising to the south and southwest of the lake is toward the valley it occupies, which, with the presence of sedimentary beds, and probably also of sheets of volcanic dust, is favorable to the occurrence of landslides. The only exceptional feature connected with the landslides at this locality is that they descended into a narrow valley, so as to completely dam it. The waters rose above the dam, but as it is composed mainly if not entirely of rock fragments, an escape by percolation was established before a surface outlet was

reached. On account of the failure of the water to overflow, it could not cut down a channel so as to drain the lake, as has occurred in other similar instances. The lake has thus been preserved, and is a typical illustration of a class of water bodies held by landslides. The larger lake differs from the smaller ones near it in that it is retained by a landslide which descended into a previously eroded valley, while the smaller lakes are of the same type as hundreds of lakelets, swamps, and waterless depressions on the surface of fallen rock masses, which may be termed true landslide basins.

The largest spring fed by Lake Waha discharges about 15 cubic feet of water per second, which is now conducted into a ditch and used for irrigation. A fall of several hundred feet could be made available for this water, and it might then be used for power; in fact, a small mill was formerly turned by it. This and other plans for utilizing the water—among them, the supplying of Lewiston—have been considered by engineers. The main difficulties developed by the investigations are the loose condition of the natural dam and the precipitous character of the borders of the lake, which render it impracticable to greatly increase its size.

TOPOGRAPHY OF THE LEVEL PLATEAUS.

There are certain features in the relief of the level plateaus underlain by the Columbia River lava, such, for example, as the Uniontown Plateau and the country in the vicinity of Pullman, Garfield, and elsewhere in Washington, which merit attention. The plateaus referred to, it will be remembered, are covered with a sheet of residual soil, usually from 50 to 100 or more feet thick, and are not smooth plains, but nearly everywhere exhibit well-marked variations in relief. In traveling over them one crosses a seemingly endless succession of hills and valleys which have differential elevations of, in general, from 50 to 150 or 200 feet. The topography is undulating, the hills forming convex elevations with steep sides, and the valleys forming concave basins. A marked feature is the absence or extreme rarity of basins without outlets, such as sinkholes. It is evident from the gradients of the valleys, notwithstanding they are gentle, that if rain water could be held at the surface of the soil a complete system of streams would be formed and lakes would be rare or entirely absent. The valleys, however, in cross section have rounded bottoms, and in most instances are without stream channels. The convex slopes of the hills merge by insensible gradations into the concave curves of the troughs between them. The hills and vales alike are composed of fine, rich soil, and no rock fragments attract attention, except in rare instances, where the hills are unusually precipitous.

The character of the relief, however, may perhaps be indicated more clearly by saying that it is such as stream erosion gives to regions com-

posed of soft rocks where weathering is rapid, but it has lost all of the small features due to the work of creeks, brooks, and rills. The stream courses have long been abandoned, and the movement of the soil on the bordering slopes, the beating of rain, the influences of frost, vegetation, etc., have subdued and to a great extent obliterated the minor inequalities due to stream erosion. It is evident from the nature of the larger elements in the topography, especially from the gradients of the shallow valleys, which are such as would furnish complete drainage in case water could be held at the surface, that streams at one time meandered over these nearly level plateaus. The valleys, however, have long been abandoned as avenues of drainage, and may be said to be slowly crumbling to ruin. One reason for this change, but perhaps not the most important, seems to be that rock disintegration and decay have been in excess of transportation, and such a depth of porous soil and subsoil has been produced that the rain water is entirely absorbed by percolation and evaporation, thus robbing it of the power to corrade. With the increase in depth of residual material there very likely was a decrease in rainfall which hastened the disappearance of surface streams.

As already stated, the sedimentary layers and beds of volcanic dust between the sheets of Columbia River lava in numerous instances contain abundant impressions of the leaves of Tertiary plants, and it seems safe to assume that the last and highest lava sheet was poured out before the close of that period. This being so, the lava plateaus have been exposed to the atmosphere throughout Pleistocene and Recent times, and have experienced the climatic changes which gave character to the Glacial epoch. In harmony with this conclusion is the fact that the surfaces of the plateaus have been exposed to the air throughout the immense length of time that witnessed the excavation of the neighboring canyons. There is abundant evidence to show that glaciers did not reach the Nez Perce region or the Palouse country, although they did exist during the Glacial epoch on the Cascade Mountains to the west and on the Rocky Mountain ranges to the east. It may reasonably be assumed that the atmospheric changes which gave origin to extensive glaciers on the mountains gave to the intervening lowlands a cold and humid climate. Since the glaciers disappeared or have been greatly reduced in size, the climate of the lava plateaus has become warmer and less humid. In a general way, then, it seems safe to refer the erosion of the level lava plateaus which gave them their moderately rough surfaces to the Glacial epoch, when precipitation was greater than now. The decrease in the size of the streams and the disappearance of all but the larger ones may be correlated with the climatic changes which followed the Glacial epoch and which still continue. With the decrease in the volume of the streams rock decay continued, and the depth of fine soil has become so great

that all of the rainfall, although now amounting to probably 30 or 35 inches a year on the higher plateaus, is absorbed, and mechanical erosion is nil.

SOLUTION BASINS.

Among the minor physiographic features of the Nez Perce region should be noted certain shallow depressions, without outlets, in the surfaces of the plateau remnants between the streams which have dissected the Columbia River lava. In some instances these depressions hold water during the rainy season and become transformed into small lakes; but in summer their beds are dry, and perhaps are coated with an incrustation of alkaline salts or are traversed by a network of shrinkage cracks. Shallow basins of this character occur on the level plateau about 4 miles west of Waha, and can be seen to advantage from the neighboring hills. In similar situations on the Clarkston Plateau, near where it merges with the northeast slope of the Blue Hills, are other shallow basins a few rods across, the bottoms of which are grass covered and do not retain water so as to form lakelets. In one of these basins a few trees are growing, but the surrounding plateau is a prairie. On the Camas Prairie also, to the southwest of Denver, several small sheets of water can be seen from Cottonwood Butte and other neighboring elevations. While several of these are artificial ponds, there is at least one natural lake in a depression in the generally level surface. Other shallow basins of a similar nature, which are wet and swampy during the winter or are grass covered and possibly have trees growing in them, will be recalled by those who are familar with the region referred to.

These basins are of the nature of the sinkholes or shallow depressions common in limestone regions, and owe their existence mainly to the dissolution of the rocks through the agency of rain water, which escapes through fissures or other openings in their floors. After a depression has been produced by the enlarging of a fissure, the subterranean channels may become closed, by the washing into them of the surface soil, so as to prevent the downward escape of water, in which case the sinkhole will be changed to a lake. In humid regions such lakes are frequently perennial, but where the rainfall is small, or where there is an alternation of wet and dry seasons, they are likely to be ephemeral.

It should be remembered that the solution basins referred to occur on flat areas, and they should not be confounded with the somewhat similar and much more common basins produced by landslides.

TORRENT-BUILT LEVEES.

In the Nez Perce region, as in many countries having a small mean annual rainfall, there are occasional torrential rains, locally termed cloudbursts. These occur at long intervals, and are local in

their extent. Frequently they leave records of their occurrence which endure for many years. Among the most conspicuous changes produced by the rush of water down steep declivities which had previously become covered with a sheet of residual soil and angular rock fragments, are alluvial cones and parallel ridges formed of angular stones left on the sides of the ephemeral torrents. The alluvial cones frequently have channels on their surfaces, showing that the water flowed over them in streams which at times bifurcated, or abandoned well-formed channels with raised borders and built new ones. The most striking results, however, are where streams originated on declivities of 10 to 15 and in places 20 to 30 degrees angle, and built parallel embankments of angular stones from a few inches to 2 or 3 feet in height. In these instances the swift streams were overloaded with coarse material, which was deposited partly on their bottoms but principally on their borders, forming levees which tended to confine the water to narrow channels. A typical example of these torrent-built levees was observed on the sides of the canyon of Captain John Creek, where in 1897 there occurred a local storm which gave birth to streams that continued less than an hour, on slopes of 20 to 35 degrees angle. The channels of these streams are still clearly defined, in fact are almost as fresh as when the waters left them. Their width varies, but in general they are from 1 to 3 feet across, and the sharp-crested ridges of stones piled up on their sides are from 24 to 30 inches high, with a width at the base but little greater than their height. The stones in the ridges are angular, and are of all sizes up to 5 inches (in some instances 8 inches) in diameter. In some cases a torrent broke through one of its embankments and sent off a distributary, which also built a well-defined pair of levees of angular stones. These parallel ridges are of the same general character as the levees of alluvial-depositing rivers, as, for example, the Mississippi in its lower course, but are sharp crested and are formed of angular stones with large spaces between them. The temporary torrents were evidently overloaded with débris, except in their swift central portions. As soon as the water which had gathered into a stream began to spread, it lost velocity as well as depth; the stones previously swept along were dropped, and an embankment was formed which tended to confine the current within narrow limits and thus enable it to build up its embankments. The small levees referred to occur on slopes where previously there were no stream channels. In the natural waterways the floods were high during the storm referred to. Captain John Creek, which in summer is a brook across which one can step, increased in a few minutes to a roaring flood charged with the branches and trunks of trees and thick with mud from 8 to 10 feet deep, sweeping along large bowlders in its path. The previously formed flood plain, which was under cultivation in at least one locality, was largely washed away

and new deposits of coarse gravel were laid down. Similar floods have occurred in neighboring canyons, as has been noted in the case of Asotin Creek, and torrent-built levees like those described can be seen on some of the steep slopes along the course of Grande Ronde River.

In Part II of this paper, published as Water-Supply and Irrigation Paper No. 54, will be found discussions of the water supply and the economic geology of the Nez Perce region, also tables of elevations in the county (Appendix A), and notes concerning Portland cement (Appendix B).

[For index, see end of Part II, Water-Supply Paper No. 54.]

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1901

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CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND WATER RESOURCES OF NEZ PERCE COUNTY, IDAHO

PART II

By ISRAEL COOK RUSSELL

WASHINGTON
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GEOLOGY AND WATER RESOURCES OF NEZ PERCE COUNTY, IDAHO.

PART II.

By ISRAEL C. RUSSELL.

WATER SUPPLY.

The sources of water supply in the Nez Perce region are streams, springs, wells, and cisterns. Of these special attention can be given here to only the springs and the drilled wells, for it is from these that the water supply must be supplemented. There are splendid rivers of clear, wholesome water flowing through this country, but they are in deep valleys and in canyons with steep, rugged walls, and for the most part are practically unavailable for economic purposes, on account of the expense of pumping or of constructing aqueducts which will conduct the water to where it can be used. Although the utilization of the surface waters can not be considered in detail in this report, a brief account of what has been accomplished in that direction will be serviceable as indicating the needs of an increased water supply. In this region water is used for navigation, irrigation, town supply, power purposes, household use, and the watering of stock.

The first of these, navigation, may be dismissed for the present with the statement that Snake River is the only stream that is navigable or that it is practicable to render navigable, on a commercial scale, for steamboats.

Fortunately, the rainfall, on account of the retentive character of the soil, is sufficient to insure good crops on all but the lowest plateaus and on the canyon walls; but in most places the results could be made still more satisfactory if recourse could be had to irrigation, especially during the height of the dry season. The areas where irrigation is now practiced are small, and most of them are along the borders of Snake and Clearwater rivers. By far the most important and successful attempt that has been made to utilize the streams is the ditch constructed by the Lewiston Water and Power Company, which diverts water from Asotin Creek about 6 miles above its mouth and at an approximate elevation of 665 feet above Snake River at Asotin, and conducts it 14½ miles to Clarkston, where part of it is

distributed, through underground mains and laterals, for town purposes and irrigation. The upper 6½ miles of the system is a flume 6 feet wide and 3½ feet deep, with a grade of 10.56 feet to the mile. This flume is on the steep northern wall of Asotin Canyon, and is carried across the numerous lateral gulches on trestles. The lower 8 miles of the system is a canal 6 feet wide at the bottom and 16 feet wide at the top, with a depth of 5 feet and a grade of 2.12 feet to the mile. The estimated capacity is 127 cubic feet per second.

Lewiston is supplied with water by a pumping station in the eastern portion of the city, which takes water from Clearwater River. Asotin derives its water supply principally from a gravity system supplied by ditches which divert water from Asotin Creek, but surface wells are also in use there. Asotin Creek also supplies power for an electric-light plant, from which electricity for illumination is distributed to Asotin, Clarkston, and Lewiston. Flouring mills in Asotin and Lewiston are run by water power. Additional sources of water power which are not yet utilized but which demand careful investigation, are to be found on Grande Ronde River, at Waha, and along Salmon River and Orofino Creek. For household purposes in villages and on farms recourse is had in most instances to ordinary surface wells, and in favored localities to springs and streams. The surface wells on the lava plateaus derive their water from the residual soil and subsoil, as a rule at a depth of from 30 to 50 feet, but the supply is frequently small and not of good quality, on account of mineral matter in solution. Drilled wells have been put down in a few cases, and some of them, as will be noted later, are very successful.

On the whole, despite the large volumes of the streams, which, as already stated, it is impracticable to utilize except in a few instances, there is a dearth of water in this region, and there is urgent need, particularly on the plateaus where grain is so largely grown, of water for household use, for the irrigation of gardens and orchards, and for watering stock; also to supply villages, in order that the surface wells may be abandoned and sanitary drainage established. And it is hoped that the improvement of springs and the sinking of artesian wells will furnish relief in many instances.

SPRINGS.

At the bottom and on the sides of the canyons and gulches excavated in the Columbia River lava, water issues as springs at many localities, but as a rule soon disappears, owing to the quantities of loose material mantling the surface. These springs are supplied by water percolating through porous beds composed, in most instances, of gravel, sand, or volcanic dust, and, less commonly, of the scoriaceous portions of the lava sheets themselves. The source of the water where the porous beds are in the upper portion of the Columbia River lava and where it has been dissected by streams to the depth

of the porous beds or lower, as in the case of the Clarkston, Lewiston, Camas, and Kamiah plateaus, is the rain falling on the broad interstream areas. The rain water is absorbed by the deep porous soil and subsoil, which usually is traversed by vertical tubes, as explained in Part I, and finds its way through the surface sheets of lava, for they usually are more or less decayed and broken by joints, and thus readily reaches any porous beds which may be present in the upper portion of the lava formation.

In some cases, however, e. g., where the strata dip away from a canyon wall, as along the south side of Clearwater River throughout the lower 20 miles of its course and on the south side of Snake River between Clarkston and Alpowa, the rain water falling on the exposed edges of the porous layers in the canyon walls, or reaching them by flowing down the slopes above, follows the inclined beds and comes to the surface in the next canyon, in the direction of the slope, which is sufficiently deep. In the neighborhood of the mountains bordering the region occupied by the lava, the gravel beds between the layers extend up the valleys to the uplands, and there are abundantly water charged. Wherever such beds have been cut by erosion, springs appear. The conditions favoring the origin of springs are increased in a most important manner by the fact that at least one widely spread bed of sand and gravel in the upper portion of the lava formation is underlain by a thick, impervious layer of clay. This double layer, consisting of sand and gravel above and clay below, as already described, underlies the Uniontown and the Lewiston-Clarkston plateaus, and probably extends eastward to the border of the Columbia River lava. The depth of the surface of the sand and gravel varies from 150 to 350 feet. The most definite sections showing its position and character are furnished by the well on Ira Small's ranch and by the exposure in a neighboring gulch.

As already explained, this soft layer has influenced the topography of the canyon walls over a wide extent of country, and its position in many localities is indicated approximately by the presence of a terrace on otherwise precipitous slopes. Near the heads of small canyons, where they first reach the horizon of the surface of the clay beneath the sand and gravel member of the sedimentary deposit, springs frequently are present. Their occurrence at these localities is due to the fact that the edge of the porous bed is there most often exposed. Owing to the quantities of more or less disintegrated rock encumbering the terrace, and especially the thick talus piles and landslides on its border adjacent to the cliffs rising above it, the water which flows out is lost to view. There is no doubt that if this surface débris could be removed an abundant outflow of water would be obtained in many places where now there is no sign of its presence. This perhaps seemingly bold statement is sustained by the fact that in prospecting for lignite on S. C. McNeil's ranch, in Grande Ronde Canyon,

a tunnel was driven in a most unpromising locality so far as water was concerned—in a landslide—and encountered such a volume of water as seriously to impede mining operations.

A typical illustration of the class of springs referred to is furnished at the head of a small gulch opening into the valley of Clearwater River near the Small ranch. Here, as already explained, erosion has cut through a layer of sand, about 60 feet thick, resting on clay. Springs appear at the surface of the clay, and the natural conditions have been improved by the removal of the loose rocks which had fallen in from above, and the placing of a pipe for conducting the water away. The strata dip southward, or away from the escarpment overlooking Clearwater River. The intake of the layer of sand is principally on the north face of the escarpment, and its flow through the bed is southward, down the slope. As will be more fully described further on, the water supply in this instance could be still further increased by excavating a tunnel, or "horizontal well," in the base of the sand layer, in a direction (eastward) at right angles to its dip.

Other examples of springs similar to the one just described are to be seen near the heads of several of the gulches which open into Asotin Creek within a radius of 10 miles of the town of Asotin. In the region referred to there are well-defined terraces about 120 and 260 feet below the general level of the adjacent plateaus, each of which is due to a sedimentary bed interstratified with the basalt. In descending the side gulches leading to the main creek, springs are found when these terraces are reached, their presence usually being indicated by a house, for in nearly every instance they have led to the location of a homestead.

The conditions on Asotin Creek are repeated along the "break" of Snake River Canyon, more particularly on its west side between Asotin and the mouth of Grande Ronde River, where a terrace is present. Below the first rim rock, and apparently dangerously near the brink of the great precipices below them, several houses are to be seen from the hills near Waha; and each house marks the location of a spring.

Other illustrations of these conditions might be offered, and many will doubtless suggest themselves to persons who are familiar with the marvelous advances that have been made in the development of the agricultural resources of the Nez Perce region. But facts enough have probably been offered to sustain the recommendation which follows, in reference to the practicability of greatly increasing the water supply derived from the pervious beds cut through by the larger canyons and many of their tributary gulches.

HORIZONTAL WELLS.

The pioneer experiment in this connection should be in the direction of enlarging an existing spring, as, for example, the one at the

head of a small gulch near Ira Small's ranch. At that locality a tunnel should be excavated at the base of the sand, its bottom being at the start perhaps 2 feet below the surface of the underlying clay, and carried eastward at least 200 or 300 feet. The longer the tunnel the greater will be the quantity of water obtained. In this and all similar instances the proposed tunnel should run at right angles to the dip of the beds, or as nearly in that direction as is practicable and still obtain the necessary slope. There are many localities nearly or quite as favorable as the one cited, for example, along the upper portion of the great escarpment bordering the Uniontown Plateau on the south, and particularly near the heads of the notches cut in its rim, and again near the head of the gulches tributary to Asotin Creek. In Tammany Hollow the same porous layer which underlies the Uniontown and Clarkston plateaus is cut through, and springs appear at its base. It is the presence of these soft beds which has given the hollow its exceptional width upstream from the place where the underlying sheet of basalt is exposed. The beds there dip gently northward, and tunnels made for the purpose of obtaining water should be located on the south side of the valley. As will be explained more fully further on, it is desirable either that two tunnels be constructed, diverging from each other at a high angle, or that a main tunnel be run directly into the bluff at the base of the porous layer and then branched like the letter Y, but at a wide angle.

The principal conditions governing the selection of a locality for excavating a tunnel or horizontal well, in case the strata are essentially horizontal, should be the presence of a broad plateau surface, which will serve as a catchment area for rain, and a break on the border of such an area where the underlying porous beds are cut through. The most favorable localities, as suggested by existing springs, are near the heads of small gulches excavated in the borders of broad plateaus. The presence of a soft bed, as already explained, is usually indicated by a terrace in the canyon walls, but may also be discovered by observing the nature of the surface débris. The coarser sedimentary beds usually contain well-worn pebbles of various kinds of rock, among which white quartz is frequently conspicuous. Such pebbles mingled with the surface débris furnish evidence regarding the position of the layer from which they came, similar in all respects to that supplied by "float" in ordinary prospecting. When the actual presence of a porous bed has been determined, its base must be reached; and for this purpose a cut will usually have to be made in the nearly universal sheet of débris which mantles the surface. On a slope where the presence of a layer of gravel is revealed in the surface material, but where no actual exposures are in sight, as is the nearly universal rule, the most practical method will be to sink prospecting pits at various horizons below the highest level at which the gravel or sand "float" appears, until the base of the layer is dis-

covered. The direction and character of the proposed tunnel will depend on the local conditions.

In order to make the suggestions just offered more tangible, fig. 5 has been prepared. This figure illustrates most of the conditions that will be met with in the Nez Perce region. It represents a plateau composed of horizontal lava sheets and containing one sedimentary bed near the surface, which has been deeply trenched by erosion. The view is supposed to be from one side of a deep canyon, and shows the strata exposed in the opposite wall and in the connecting side canyon and gulches. The most favorable localities for horizontal wells would be at *a*, *b*, and *c*, and the general direction they should take is indicated by dotted lines. In each case two tunnels are suggested, the object being to intercept as much of the percolating water as practicable. The length of the tunnels will be controlled by local

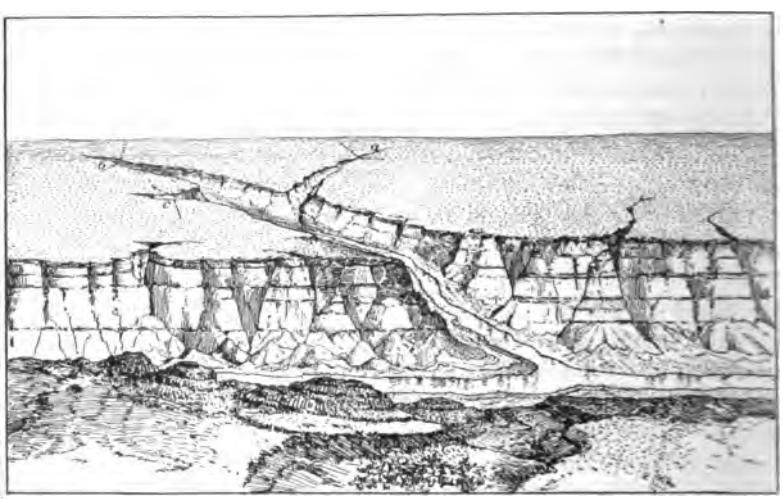

FIG. 5.—Dissected lava plateau, showing best locations for horizontal wells.

conditions, but in general, in the region about Lewiston they can be extended almost indefinitely, the ratio between expense and water supply being the governing factor.

In the illustration horizontal strata are indicated. The most favorable conditions would be furnished, however, where the strata beneath a broad plateau dip toward a canyon wall in which the cut edge of a porous layer is exposed. For example, if the strata shown in fig. 5 dipped toward the point of view, one tunnel only would need to be run at *a*, while at *c* the chances of obtaining water would not be worth considering. If the strata should be inclined downward from right to left, two tunnels at *a* would be advisable, as indicated, but only one running in the direction of the line of the gulch would be required at *b*, while at *c* no water could be obtained. The sketch may perhaps be considered as indicating that springs would occur all

along the canyon walls, and such, to some extent, would no doubt be the case under similar conditions; but the canyon walls, at least in the Nez Perce region, are so heavily sheathed with débris that only an unusually strong spring can give surface indications of its presence, except near the head of a small gulch. More than this, when a pervious bed is exposed for miles in the wall of a canyon there is such freedom for the water it contains to escape by seepage that definite springs are not likely to occur. Near the heads of lateral canyons and gulches, however, the conditions are different, and a concentration of the percolating waters is favored. The writer repeats the suggestion that the most favorable localities for excavating horizontal wells are near the heads of small gulches where pervious beds are first cut through.

Considerable space has been given to the consideration of the conditions which favor success in searching for water by means of horizontal wells, for the reason that through the lava-covered portion of the Nez Perce region and a still greater area of similar character in the neighboring portions of Washington and Oregon, there is a combination of circumstances—such, for example, as deep porous soils and subsoils which absorb rain water, the presence of sedimentary beds between the lava sheets, the manner in which the surface layers of lava are weathered, the deep canyons with small lateral branches that abound, etc.—which justifies the making of trials in this connection at numerous localities.

In the last few pages attention has been directed mainly to the sheet or sheets of porous beds near the surface of the Columbia River lava, because these are favorably situated to be supplied by local precipitation. There are other similar beds, however, at varying depths, down to more than 3,000 feet, as has previously been explained, and where any one of these appears in a canyon wall and is underlain by an impervious bed horizontal wells may be expected to yield a water supply. The most favorable of these localities are where the pervious beds first appear as one descends a canyon which has been cut sufficiently deep to reach them.

ARTESIAN WELLS.

GENERAL PRINCIPLES.

An artesian well is understood to be an excavation in the rocks, usually a hole a few inches in diameter made by drilling, through which water rises to the surface and overflows. No definite line can be drawn between wells that are truly artesian and many others in which water rises by hydraulic pressure, except in reference to a surface flow.

The primary condition necessary to the obtaining of flowing water by drilling is that water exists under sufficient pressure to force it to

the surface when an opening is made for its escape. The force which sends the water to the surface is, in most instances, the pressure of water at higher levels; that is, hydraulic pressure.[1] This is illustrated by the manner in which many towns are supplied with water from storage reservoirs. There is no difference in principle between an artesian well and the flow of water from a faucet in one's kitchen, and a continuous and nonperforated tube through which water can rise is as essential in the case of an artesian well as it is in the water mains and laterals of a city.

Experience has shown that the most usual conditions which permit the accumulation of water in rocks so as to be under pressure are the presence of a porous bed, such as gravel, sand, and even quite compact sandstone, or beds of much more impervious rock traversed by fissures inclosed between two water-tight or impervious beds or strata, such as clay, shale, etc., and the series thus arranged having a basin shape or rising in all directions from a central area. An additional condition requisite to maintaining a continuous flow is that the upraised edge of the porous water-charged layer should be exposed at the surface so that it may receive additional water. These condi-

FIG. 6.—Section illustrating the chief requisite conditions for artesian wells. *A*, a porous stratum; *B* and *C*, impervious beds below and above *A* acting as confining strata; *F*, height of water level in the porous bed *A*, or, in other words, height of the reservoir or fountain head; *D* and *E*, flowing wells springing from the porous water-filled bed *A*. (After Chamberlin.)

tions are illustrated in fig. 6, an ideal section indicating the arrangement of rocks to a depth of a thousand feet beneath a valley 20 miles wide. Other sections across the valley in any direction would show essentially the same conditions.

Rain falling on the exposed edge of the porous bed *A* percolates through it until it becomes thoroughly water charged. The water at any point in the bed is then under the pressure of the waters at higher levels, and if a hole be drilled, as at *D* or *E*, it will rise and overflow at the surface. If a tube be connected with one of these openings and carried up above it, the water would rise in the tube until it stands on a level with the lowest notch in the rim of the water-charged layer. This would determine the *artesian head* for the basin. At all points within the basin where the surface is below the level of the artesian head, a surface flow could be obtained by drilling a well down to the porous layer.

While fig. 6 will, the writer thinks, make clear the primary condi-

[1] Among the agencies which might cause a pressure on water confined in porous beds or in fissures are gas, steam, and the compression of the rocks themselves, owing to the weight of the material resting on them, but examples of flowing wells in which the rise of the water is due to other agencies than hydraulic pressure are, the writer believes, unknown.

tions governing the flow of artesian wells, there are certain important secondary conditions which need to be considered in individual cases. One of these, of special importance to well drillers in the Nez Perce region, is that the rocks above a porous stratum may not be impervious all the way to the surface, or the upper impervious bed may be overlain by porous material, so that water would not rise to the surface where an opening is made, although the pressure be sufficient, unless the well is properly cased so as to prevent lateral flow. Another consideration to be borne in mind is that the rainfall on the exposed margin of the porous layer should be sufficient to maintain the flow of the wells opening into it.

A true basin shape in a porous layer inclosed between impervious beds is not essential to an artesian flow, however, for any porous bed in which water is confined which is so situated that it can be recharged from the surface and an opening be made where the surface is below the intake will permit of a surface flow. For example, in the filling of a valley there may be an alternation of clay and sand, such as is indicated in fig. 7, which would permit the obtaining of a surface flow at the locality marked W.

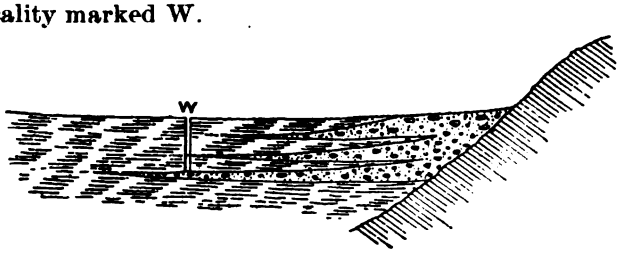

FIG. 7.—Ideal section of the border of a basin deposit, illustrating possible artesian conditions.

In the Nez Perce region the conditions illustrated by both figs. 6 and 7 have to be considered. As has already been described, the Columbia River lava was poured out in successive sheets, and in several instances between adjacent sheets there are beds of clay, sand, gravel, volcanic dust, and lapilli. The layers of clay are impervious, as is also the solid basalt, unless fractured or jointed, while the other beds mentioned are pervious and in a condition to become water charged. If the series of strata referred to should become bent into a basin shape, and the edges of the porous beds be exposed so as to receive water, it is evident that the conditions illustrated in fig. 6 would be produced and artesian wells be possible. Again, from the manner in which the layers of sand, gravel, volcanic dust, and lapilli interbedded with the Columbia River lava were formed, it follows that conditions similar to those illustrated in fig. 7 may be present, even where the rocks have not been deformed so as to produce basins. For example, taking the beds of sand and gravel, which are the most promising, we know that the material forming them was carried by streams and spread over the Columbia River lava at various times

during the periods intervening between the lava floods. In many instances these beds are of the nature of alluvial fans, and are thickest adjacent to the mountains from which the material composing them was derived, and thin out and become finer at a distance from their source. On the lava plains which were overspread in this manner there were at times lakes in which clay was deposited, so that an alternation of pervious and impervious beds may be expected. In this connection it is important to remember that the alluvial deposits spread out between the lava sheets were laid down mainly at the mouths of valleys in the adjacent mountains, and that their summit portions extended far up the valleys. As sheet after sheet of lava was poured out, each successive layer extended farther up the valleys than its predecessor, but probably never covered the higher portions of the alluvial deposits previously formed. Thus the layers of sand and gravel between the sheets of lava are favorably situated for becoming water charged.

The conditions just described may perhaps be made clearer by an

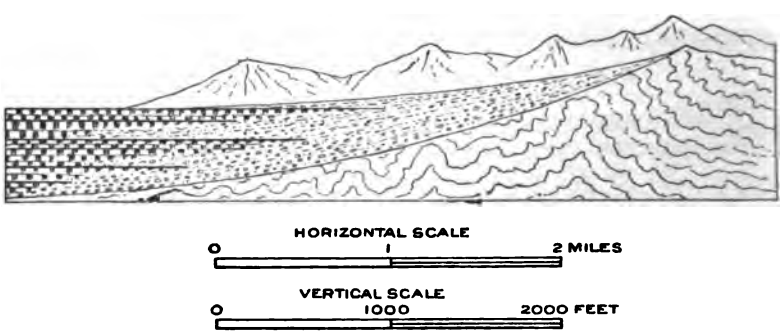

FIG. 8.—Ideal section of the border of the Columbia River lava adjacent to mountains.

examination of fig. 8, an ideal section at the border of the lava formation and extending up a valley in the preexisting mountains. The mountains in the background are intended to represent the far side of the lava-floored valley. It will be noted that this section, which represents the general conditions that obtain about the border of the Columbia River lava, is much like the one forming fig. 7, except that lava flows are added. Under the conditions illustrated it is evident that a well drilled through the lava sheets until a porous water-charged bed is reached should yield a surface flow, provided the mouth of the well is below the exposed portion of the pervious layer, and also provided that there is an unbroken impervious bed both above and below it. What has just been stated in general terms illustrates in a qualitative way the actual conditions in the Nez Perce region.

LEWISTON-CLARKSTON BASIN.

In the region about Lewiston-Clarkston, as already explained, the rocks have been depressed so as to form the Lewiston and Clarkston

plateaus. The northern border of this depressed area is defined by the Clearwater escarpment. The downward inclination of the surface of the plateaus and of the lava sheets, etc., composing them, is northward at a low angle, probably not exceeding 2 degrees. These relations are indicated in fig. 1. The Lewiston and Clarkston plateaus have also been deformed in their relations to each other, the former having been upraised along its eastern and southeastern margins, where it joins Craig Mountain, and the latter upraised along its southwestern margin, where it passes into the Blue Hills uplift. An east-west section across the two plateaus, passing through any point between Clarkston and Asotin, would exhibit the essential features shown in fig. 2.

The resultant of the three main movements which have affected the Lewiston and Clarkston plateaus is such as to give the lava sheets and their contained sedimentary beds an inclination toward the sites of the towns for which they are named. An irregular basin has thus been formed, the deepest part of which is near the center of its northern and sharply upturned border; that is, at Lewiston-Clarkston.

So far as the geologic structure, or the positions which the strata occupy, is concerned, it is evident that the Lewiston-Clarkston Basin has the features requisite for furnishing artesian water. Regarding the necessary succession of pervious and impervious beds, however, our present information is both limited and indefinite. Although the strata are well exposed in canyon walls, no porous layers within an artesian basin cut by canyons, except under certain special conditions, can be expected to retain water under pressure. To learn what strata are present below the bottoms of the canyons one is constrained to study the geology of the surrounding region over a wide area; but such examinations as it has been practicable to make in this connection have not furnished the detailed information desired.

As already stated, porous sedimentary beds highly favorable for the passage of water through them are interstratified with the Columbia River lava in Little Canyon, in the canyon of Orofino Creek, and along the South Fork of Clearwater River at from 750 to 800 feet, and in Salmon River Canyon at 3,500 feet, below the surfaces of the adjacent plateaus. It is possible that one or more of these beds occur in the Lewiston-Clarkston Basin, but positive evidence that such is the case is lacking. There is a probability also that other sedimentary beds not yet recognized may be present.

In addition to the evidence derived from natural exposures, we have, in one successful well, what may be claimed to be a crucial test of the artesian conditions.

Wells in Tammany Hollow.—In Tammany Hollow, about 8 miles southeast of Lewiston and, according to aneroid measurements made by Mr. John Adams, 500 feet higher than Main street in that city, or

about 1,200 feet above the sea,[1] six drilled wells have been put down, four of which furnish flowing water and are true artesian wells. The records of these wells are somewhat indefinite, but the following data concerning them seem to be authentic.

On the farm belonging to Charles Dowd four drill holes have been made. The first of these was begun in 1896, and the others between that year and the summer of 1900. Well No. 1, at Mr. Dowd's house, has a diameter of 8 inches, and, as reported by Mr. Dowd, passes through the following material:

Section at well No. 1, on farm of Charles Dowd.

	Feet.
Yellowish soil, clay-like in consistency	40
Basalt, hard, mostly black, but with scoriaceous portions	170
Total depth	210

Since this record was obtained, the writer has been informed by Mr. E. H. Libby that this well has been deepened 40 feet and now has a total depth of 220 feet. There is, then, a discrepancy of 30 feet in the records obtained. At the time of the writer's visit (June 28, 1900) this well was cased, but some water rose outside the casing; within the casing water rose to a height of about 20 feet above the ground, but the full height to which it would rise in an open tube was not measured. At an elevation of about 4 feet above the ground the discharge was from 15 to 20 gallons a minute. The deepening and recasing or readjustment of the old casing since the date mentioned, as the writer has been informed by Mr. Libby, resulted in increasing the flow to 105 gallons a minute. The water is clear, tasteless, without appreciable quantities of gas, and evidently of good quality. The temperature, as measured by Mr. John Adams on December 8, 1900, was 58¾° F. A copious spring a few rods distant had a temperature of 54°, and the air a temperature of 48°.

Wells Nos. 2, 3, and 4 are in a group within a radius of about 150 feet, about 1,000 feet west of Mr. Dowd's house, and approximately 30 feet higher than the surface at well No. 1. The temperature of these wells, as determined by Mr. John Adams, is from 66° to 68° F.

Well No. 2 has a diameter of 5 inches, and is reported by Mr. Dowd to pass through the following strata:

Section at well No. 2, on farm of Charles Dowd.

	Feet.
Yellowish clay, with quartz pebbles	30
Soft yellowish clay	70
Basalt	1.5
Sand, soft, "clay sand"	(a few inches)
Total depth about	100

This well is poorly cased, and water rises to the surface and over-

[1] See table of elevations forming Appendix A.

flows both within and outside of the pipe. The flow is estimated to be from 4 to 5 gallons a minute.

Well No. 3 has a diameter of 5 inches, narrowing to 4 inches near the bottom, and passes through essentially the same materials as did well No. 2. Water overflows both within and outside of the casing, and is about the same in volume as in well No. 2.

Well No. 4 has a diameter of 5 inches, and passes through the following strata:

Section at well No. 4, on farm of Charles Dowd.

	Feet.
Clay	75 to 80
Basalt	200
Greenish clay	30
"Slate," soft	3 to 4
Total depth about	314

There is a small surface flow, and the casing is defective.

In reference to wells Nos. 2, 3, and 4 there seems no reason to doubt that if they were cleared out and properly cased a good surface flow of water would be obtained.

About 1 mile north of the wells just described, on the farm of J. A. Nelson, in Tammany Hollow, near its northern border, a well was put down in 1898–99 in which the following layers were passed through, according to the recollection of Mr. Charles Dowd:

Section at well on farm of J. A. Nelson.

	Feet.
Clay	100
Basalt	20
Coarse, sharp sand	3
Basalt	80
Total depth about	200

When the 3-foot layer of sand was penetrated water rose to within 35 feet of the surface, and has since remained at that level. The well is not cased. The water in the porous layer is under pressure, and if the well were properly cased it might be expected to rise to the surface and overflow.

About 2 miles east of the Dowd wells, and in the same valley or hollow, on the farm of A. S. Wisner, where the surface is about 100 feet, by aneroid measurement, above Dowd's well No. 1, a drill hole was put down a few years ago which is reported to have passed through the following strata:

Section on farm of A. S. Wisner.

	Feet.
Gravel	25
Clay, compact	105
Basalt	86
Total depth	216

No water was obtained.

A surface well a few rods distant penetrated the following strata:

Section at well on farm of A. S. Wisner.

	Feet.
Sand and gravel	25
Yellow clay, changing to bluish below	25
Total depth	50

The clay in this well is highly charged with volcanic dust and contains leaf impressions. Water was obtained, by percolation, at the base of the layer of sand and gravel, and the excavation below that level furnishes a reservoir for storing the water which comes in from above.

In addition to the drilled wells noted, there are reports, without details, of a dug well 40 feet deep about 1 mile north of Wisner's well, at a surface elevation 50 feet higher, which is all in basalt and failed to reach water. Also about 1 mile south, on the farm of F. Crutinger, where the surface is about 125 feet higher than at Wisner's well, a well 200 feet, all in basalt, failed to reach water.

At many localities in Tammany Hollow water is obtained in surface wells at depths of from 30 to 40 feet, and along the sides of the valley there are several springs.

The bearing of the evidence obtained in Tammany Hollow, with reference to the artesian conditions in the Lewiston-Clarkston Basin generally, may be summarized as follows:

Tammany Hollow is a basin due to erosion which has cut through the surface sheet or sheets of basalt and exposed a layer of sand and gravel resting on clay. These sedimentary beds are the same as those penetrated by the drill hole on Ira Small's farm, and outcrop on the south side of Clearwater River, as already explained. Tammany Hollow owes its exceptional width (about 1 mile at the bottom) to the widening of the excavation made by the creek which flows down it, in the soft sedimentary beds lying above the sheet of basalt through which the creek has cut. Downstream the valley becomes narrow and the stream flows over basalt. Most of the springs along the side of the valley are fed by water percolating through the upper member of the sedimentary beds, and offer favorable opportunities for increasing their flow by means of horizontal wells, as already explained.

The drilled wells, the records of which, so far as available, have been presented, all start in the sedimentary beds referred to, but, with the possible exception of the Nelson well, evidently do not derive an appreciable portion of their water supply directly from that source. This is evidenced by the fact that the porous upper member of the sedimentary beds has been cut through by erosion, and although furnishing springs it can not be expected to retain water under sufficient pressure to cause a surface flow in a well begun at an elevation of a hundred feet or more above the bottom of the hollow. More than this, the same sheets of sedimentary material have been cut by Snake

River, Sweetwater Creek, and other streams, and can not be expected to convey water from a distance. Additional evidence is furnished by the temperatures of the Dowd wells, which, as already recorded, are 58¾° and 66° to 68°. The mean annual temperature in Tammany Hollow, as near as can be judged from the climatic records of the region in which it is situated, is from 48° to 49° F. As is well known, seasonal changes in temperature in localities of similar geographic position to the one under consideration disappear at a depth of about 50 feet below the surface. At that horizon there is a uniform temperature which corresponds with the mean annual temperature at the surface. Below that horizon there is an increase in temperature of about 1° F. for approximately each 60 feet in depth. The well at Mr. Dowd's house has a temperature of 58¾°, which indicates that its water comes from a depth of at least 540 feet, while the three wells about 1,000 feet to the westward have temperatures ranging from 66° to 68° and must be supplied from a depth of at least 1,140 feet.

Here we are met with the apparently anomalous fact that well No. 1, with a strong flow, is 10° lower in temperature than the neighboring well, with a weak flow; but as wells Nos. 2, 3, and 4 are practically uncased, the actual amount of water rising from a depth is perhaps even greater than is discharged by well No. 1, which has a fairly good casing. Well No. 4, however, is about 100 feet deeper than well No. 1 and should have a somewhat higher temperature, and under the conditions present it may be expected to influence the temperature of the wells drilled near it.

The only conclusion which seems justifiable in reference to the source of the water at the Dowd wells is that it comes from a depth of more than 1,000 feet below the surface, through fissures in the Columbia River lava, and in part spreads out in the interstratified porous sedimentary beds. The spring near Mr. Dowd's house has also a deep source, as is shown by its temperature, but, the water rising less freely than in the neighboring wells, in its passage upward it is cooled to 54°. The recent deepening of well No. 1, which increased its flow, is also in harmony with the conclusion that its water is received from fissures.[1]

Recommendations.—The success of the Dowd wells must be considered highly favorable to obtaining artesian water throughout a large area within the Lewiston-Clarkston Basin, but it is not as reassuring as might be wished, for the depth below the surface from which the water comes is not definitely shown. It is very encouraging to know, however, that at a depth of about 1,000 feet a porous stratum probably exists which contains water under sufficient pressure to cause a surface flow at an elevation of more than 500 feet above Lewiston. A word of caution is perhaps necessary here, inasmuch as the

[1] It may be suggested that if a charge of dynamite were exploded at the bottom of this well its flow would be still further increased.

facts in hand do not prove the presence of a water-charged stratum. There is a possibility that the water referred to finds its way from distant uplands through fissures, but what is known concerning the presence of sedimentary beds at various horizons in the Columbia River lava does not favor this view.

Having before us all of the facts which it is practicable to obtain at the present time concerning the general question of procuring artesian water in the Lewiston-Clarkston Basin, the conclusions must be largely controlled by considerations of expense. No one can say positively that success would follow the putting down of a drill hole at a certain locality, but from a geologic point of view the experiment is well worth trying. The most favorable location for the pioneer well is in the lowest part of the basin, and, fortunately, that is where the demand for water is greatest. The lowest level of the basin is at Lewiston-Clarkston, but the test should be made at as great a distance as practicable from the Clearwater escarpment. The writer recommends that a boring be made in Lewiston, preferably on the upper terrace on which the newer portion of the city is built, as, for example, in proximity to the public-school building. The chances, however, are equally good, and possibly better, in Clarkston. If the latter locality is chosen, the boring should be made in the western portion of the city, near the base of the "first bench." If a trial is made at either of these localities, the boring should be carried down to a depth of at least 3,000 or 4,000 feet, unless a sufficient water supply is obtained at a less depth, or the formations which underlie the Columbia River lava are reached. There would be no excuse for continuing to drill after granite, diorite, mica-schist, limestone, shale, etc., are entered; but soft beds containing the débris of such rocks must not be mistaken for the rocks themselves in place. A successful boring at either of the localities recommended would establish the artesian head of the basin and indicate the horizon below which other wells might be expected to yield a surface flow. Owing, however, to the lack of knowledge concerning the topography of the old land surface over which the Columbia River lava was outpoured, all portions of the basin below the artesian head determined from a pioneer well might not yield equally favorable results. The presence of diorite ("granite") blocks on the hillside a mile or two southeast of Lewiston and the reported discovery of similar rock in place near the same locality seem to indicate that the older formations there rise through the lava. If this be true, the region immediately about Lewiston-Clarkston would probably be cut off from the source of water which supplies the wells in Tammany Hollow.

CAMAS-KAMIAH BASIN.

To the east of Craig Mountain, and intervening between that uplift and the foothills of the Bitterroot Mountains, is a broad, shallow, structural basin, the nearly flat central part of which is occupied by

the Camas and Kamiah prairies. The rim of the basin is well defined on all sides, except perhaps to the north, where the Craig Mountain monoclinal fold flattens out. The dip of the sheets of lava away from the uplands of older rocks to the eastward is slight, but judging from the inclination of the plateau remnant between the streams, it is definite and continuous for a distance of several miles toward the center of the depressed area. Within the basin, as already described, there are thick beds of sandstone, shale, etc., interstratified with the lava sheets. Thus the conditions in reference to both geologic structure and succession of beds in general favor the existence of water under pressure in the porous beds. Information concerning the composition and order of succession of the strata below the depths to which canyons have been cut is wanting. The canyons in the central portion of the basin, as Lawyers Canyon and Little Canyon, have a depth of about 1,000 feet, and the South Fork of Clearwater River flows through a canyon fully 1,800 feet deep. No water under sufficient pressure to cause a surface flow could therefore be expected at a less depth than the canyons have been cut, except, as will be explained further on, where broad plateau remnants adjacent to the mountains exist between the streams.

The success of deep wells in this basin, or in the Lewiston-Clarkston Basin, hinges on the presence or absence of the requisite succession of pervious and impervious beds and the topography of the old land surface beneath the lava. Neither of these uncertain factors can be determined from natural exposures, although some light respecting the succession of beds beneath the Camas Prairie may perhaps be obtained in Salmon River Canyon, and must be discovered, if learned at all, by means of the drill. The basin is, however, situated so near the mountains bordering the Columbia River lava that it is more than likely several sedimentary beds exist and that the requisite arrangement of one or more pervious beds between impervious ones is present. In the writer's opinion, the conditions in this basin are such as to warrant the drilling of a test well, provided the demand for water is sufficient to justify the expense. The pioneer well should be located in the lowest portion of the basin, as, for example, in the vicinity of a line joining Cottonwood, Howard, and Steele, or midway between Kippen and Kamiah. While the making of such a test in this region is justified from geologic considerations, the cost would probably be far greater than the best results to be hoped for would warrant. The test well should be carried to a depth of at least 3,000 feet, unless successful results are attained at a less depth, or the rocks which underlie the Columbia River lava are reached; and the expense would probably be greater than the utilization of the water for irrigation purposes would justify. Seemingly, it is only for the supply of towns of considerable size that such an experiment as has been suggested should be made.

A portion of the Camas-Kamiah Basin adjacent to the base of Mount

Idaho, embracing an area of about 200 square miles, has a gentle slope northward, and is uncut by canyons more than one or two hundred feet deep. Beneath this area there are porous beds at no great depth, as is shown in part in the canyon walls and in part by borings that have been made. While some of these porous beds are cut by the shallow canyons, others pass under them and should furnish water under pressure. The principal hope of obtaining flowing water in this region is based on two principles: (1) That the pervious beds composed of unconsolidated débris swept out from the mountains and covered in part by lava may change and become impervious at a distance from the source of supply. (When this happens, and the bed is inclined and overlain and underlain by sheets of impervious material, a well put down in its coarser portion should yield a surface flow.) (2) That the flow of water through an inclined porous bed having impervious beds above and below is retarded by friction and may yield a surface flow at certain localities, although it is cut by a canyon at a distance.

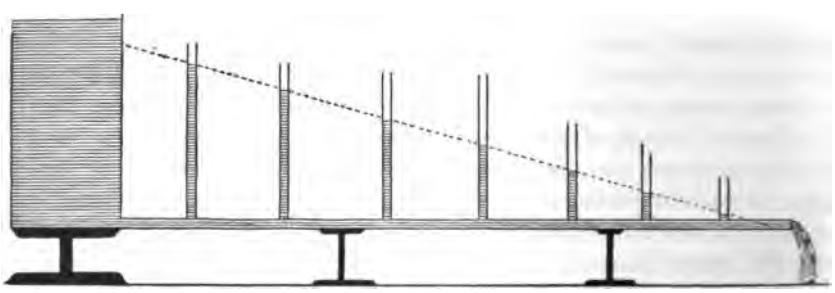

FIG. 9.—Diagram of apparatus illustrating the declivity of head of liquids flowing from a reservoir.

The first of these principles is self-evident, but the second may perhaps require further explanation.

That water confined in an inclined porous bed may, owing to the friction of flow, rise to the surface in case wells are drilled midway down its slope, is proved by an experiment such as is illustrated in fig. 9.

In the region about Denver, in the southern portion of the Camas Prairie and probably extending as far westward as Cottonwood, the slope of the strata is northwestward at a low angle, or away from the bold escarpment known as Mount Idaho. This mountain was not visited during the reconnaissance which forms the basis of this report, but, judging from its topography and from observations made by others, it no doubt is composed of rocks of older date than the Columbia River lava, and forms a portion of the boundary of that formation. Débris from this ancient upland swept down upon the Columbia River lava at various times during the intervals between the eruptions which gave origin to its numerous sheets, and should occur and be favorably situated to be charged with water. That such beds are

present between the sheets of lava has already been shown. They may be expected to be thickest adjacent to the mountain from which the débris composing them was derived, and to thin out and become finer in texture toward the center of the basin on the inward-sloping side of which they occur. This indicates that the two principles in reference to artesian conditions may there find application, and the facts furnished by certain wells that have been drilled seem to bear out these conclusions.

Wells at Denver.—Such facts as it has been possible to glean concerning the several wells put down on the Camas Prairie, principally at Denver and vicinity, are here presented. In most instances the information has been furnished from memory by persons who were present when the wells were drilled.

A well drilled on the farm of N. Nelson, 1¼ miles east of Cottonwood, in 1899 passed through the following strata:

Section at well on farm of N. Nelson.

	Feet.
Surface soil and subsoil containing fragments of basalt	40
Soft basalt	26
Gravel, soft, easy to drill	52
Total depth	118

Work was discontinued on account of an accident to the drilling rig. Water was obtained in the gravel and rose to within 66 feet of the surface, but did not overflow. The well does not seem to have been properly cased.

At Denver five drill holes have been put down, the records of which, so far as it is now practicable to obtain them, are as follows:

Well No. 1: Near Parker's mill; drilled in 1893; total depth, 202 feet; hard rock not reported; water rose gradually from near the bottom to within 90 feet of the surface; supply large; pumped by means of windmill and steam power, and used for boilers in the mill; wooden casing for first 100 feet.

Well No. 2: Under Parker's mill; distant about 150 feet from well No. 1; drilled in 1895-96; no solid rock reached; the first 110 feet in soil and subsoil containing blocks of basalt; sand and clay containing white pebbles (quartz) at 100 feet; at 140 feet the sides caved in and many tons of sand were taken out; water rises to within 90 feet of the surface; supply small; an abundance of water reached at 205 feet, but could not be utilized, owing to the caving of the walls; well has a wooden casing down to a depth of 140 feet, and a galvanized-iron tube within it to a depth of 90 feet.

Well No. 3: In the central part of the town, about a half mile from well No. 1 and at an elevation 50 to 60 feet greater; total depth, 235 feet; a little water obtained at 100 feet, a large supply at 200 feet; the water rises to within 100 feet of the surface; iron casing for a short distance from the surface, to retain loose material, and a 2½-inch iron pipe within, for pumping, which reaches a depth of about 200 feet; water now pumped by steam power and windmill for town use.

Well No. 4: In the northern portion of the town, about a half mile from well No. 3 and 20 feet higher; said to have been drilled entirely in loose material; total depth, 325 feet; water rose to within 90 feet of the surface; not used.

Well No. 5: In southeastern portion of the town: was abandoned at a depth of 100 feet.

Within a radius of about 3 miles of Denver and to the south of the town four other wells are said to have been put down to depths varying from 100 to 220 feet, but not one of them furnishes flowing water. One of them, on the farm of C. B. Kanos, was sunk to a depth of 200 feet in solid basalt. Another, 2½ miles southeast of Denver, excavated mostly with pick and shovel, according to the statements of Mr. W. H. Zumwalt, passed through the following strata:

Section 2½ miles southeast of Denver.

	Feet.
Soil and subsoil	16
Rock (basalt)	31
Soft material of various colors	93
Total depth	140

Plenty of water was obtained at 136 feet, and maintains a depth of 10 feet; used for farm purposes. Another well, 1½ miles south of Denver, on the farm of Isaac Zehner, passed through soil and subsoil to a depth of 80 feet, and then through 140 feet of basalt. The total depth of the well is 220 feet. Water was reached at 200 feet; did not rise; is used for farm purposes.

The great variations in the nature of the rocks passed through in the sinking of the wells in and about Denver show that the surface portion of the formations undergoes marked changes within short distances. In the town wells no solid basalt was encountered, while 2½ miles to the southeast, on the Kanos farm, basalt with a thickness of 31 feet was reached at only 16 feet beneath the surface. It overlies soft beds of variegated colors, such as presented by the sedimentary beds beneath the upper lava sheet on Grande Ronde River and at other localities. The reason for these variations has not been thoroughly determined. The facts in hand seem to indicate, however, that the surface sheet of basalt at Denver has been eroded away or decayed, while in neighboring localities it still remains and is but little changed. The explanation offered on a preceding page—the rough topography of the level plateaus—may apply here. That is, the surface sheet of basalt at Denver was cut by stream channels during a period of more active erosion than is now in progress, the surface evidence of which has been obliterated by subsequent movements in the loose superficial material. The mountains, however, are only 10 or 12 miles distant, and alluvial material may have been deposited on the previously eroded and weathered surface sheets of basalt, thus again concealing the changes previously produced in its relief. Sufficient time was not available to test these suggested hypotheses in the field.

The wells thus far put down on the Camas Prairie, although showing that water under pressure exists in certain layers, do not furnish a fair test of the artesian conditions. None of the wells are properly cased; but the fact that in those at Denver the water rose more than 100 feet above the level of the point where it was first reached gives evidence of true artesian conditions. It is probable that if these wells should be properly cased a surface flow would be obtained.

The structure of the rocks beneath the Camas Prairie and what is known concerning the texture of the beds, as well as the information furnished by the wells that have been drilled, favor obtaining flowing water at a depth of a few hundred feet in the region about Grangeville, Denver, and Cottonwood.

SUGGESTIONS AND RECOMMENDATIONS.

For the benefit of the people in the Nez Perce region who are directly interested in the search for water, and to whom the experience in well drilling gained elsewhere is not easily accessible, the restatement of a few well-known principles bearing on the general subject of artesian wells may, perhaps, be welcome. The following suggestions have been taken principally from a paper by Prof. T. C. Chamberlin, the title of which, together with references to other treatises on the same subject which may profitably be studied by well drillers, is given in the list of references presented in the bibliography on page 130.

Attention has already been called to the fact that none of the wells in the two artesian basins described are properly cased, and in several instances no attempt has been made to insert the necessary pipes through which the water can rise. As the material passed through, especially near the top, is open and porous, it would be a surprise in most cases if water should rise through it to the surface. The importance of casing wells can not be overestimated, for it is no more reasonable to suppose that water can rise through a hole drilled in open and porous material than that it can rise to the third story of a house if the supply pipe in the basement is full of holes.

The usual method of preventing the escape of water on the outside of the casing of an artesian well is to surround the casing just above the water-bearing stratum with a bag made of leather or rawhide and filled with dry flaxseed. The flaxseed absorbs the water and swells and expands the bag so as to shut off the water from the space outside the pipe. The method of attaching the bag is shown in fig. 10.

Another method for obtaining the same result by means of rubber disks is described and illustrated by Chamberlin in the article referred to.

By means of a seed bag tests can be made which will reveal the most desirable position for the lower end of the casing. In this con-

nection the following quotation is made from the paper by Chamberlin:

The water may rise from the bottom to some higher portion of a well, and there find escape by passing laterally through the upper strata, and fail to overflow. It is a matter of some practical moment, therefore, to know when a stream is struck which may yield a flow at the surface when put under proper control: (1) Such a stream usually discovers itself by a rise of water in the well, but this is not always the case. (2) Some influence on the action of the drill is liable to be felt, which may arouse suspicion. (3) In any instances of a strong flow, the drillings are apt to be carried away, so that when the sand-pump fails to bring these up, or brings only coarser material, there is good reason to believe that a stream has been struck and the proper test should be made. It is ordinarily desirable to test the capacity of any stratum which gives any of these or other indications, before sinking to a lower one. It is advisable to make provision in the contract for such tests, since it is not always to the interest of the driller, once his machinery is set up and well at work, to stop at the more limited depth. The capabilities of the flow may be tested by the use of a tube and seed-bag, or by rubber packing, as explained above.

FIG. 10.—Seed-bag packing around well casing. *a*, Delivery tube leading to the surface of the well and terminating below the seed bag; *c*, leather bag filled with dry flaxseed; *b*, marline wrappings to secure the ends of the seed bag. (After Chamberlin.)

It is possible, in perfect honesty, to make both a negative and a false test. Suppose that two porous beds, A and B (fig. [11]), separated by an impervious layer, are traversed, and the testing of the first has been neglected, either because it failed to give encouraging indications or for other reasons. It is now desired to test these. Suppose the seed-bag or rubber packing be placed above the upper one. Now, if both bear a water level equally high, the test will be fairly made, and the result will indicate their combined capacity; or, if both heads are at least as high as the surface at the well, the test may be accepted. But suppose that the bed A has been cut into by erosion, or been reached by crevices, or is otherwise defective, while the other, B, remains intact and bears an elevated fountain-head. Under these conditions the water may flow from B through the bore into A, and escape laterally through it, as illustrated in the figure. Now, in this case the result may be either simply negative or positively false and misleading. If the lateral leakage through the stratum A effectually disposed of the flow from B, and there was no leakage in the upper portion of the well, the water in the test-tube would stand during the test at essentially the same height as before, and the result would be negative, merely failing to indicate a possibility that really existed. If, on the other hand, there was lateral leakage through the upper strata as well as through A, neither alone being quite competent to dispose of the flow from B, then the introduction of the test-pipe would cut off the upper leakage, leaving the bed A unable

FIG. 11.—Section of well, illustrating a negative test for water under pressure (After Chamberlin.)

to dispose of the entire flow. In this case there would be a rise of water in the tube, and, possibly, a flow. The mischievousness of a test of this sort lies in the fact that it appears to be a true test, because it shows some result, while in reality it is false and misleading. The true test in this case can only be made by placing the packing between the porous beds A and B.

FIG. 12.—Section of well, showing a partial and misleading test for water under pressure. (After Chamberlin.)

Take another instance where two porous beds, as A and B, figure [12], have been traversed. Let the packing be placed between these. Then (1) if A equals B in productive capacity, water will stand at the same height within and without the test-pipe *if there is no leakage in the upper beds.* (2) If the failure to flow was due to such leakage, then a flow will result from B, but the additional flow which might be secured from A is lost (see figure). (3) If A has a greater head than B, and if there is no loss above, the water in the test-pipe will actually be lower than that outside, as illustrated in figure [13]. This may be said to be an *inverted test*, and is less misleading than the false and negative tests, since it plainly indicates an error of manipulation. I have known such a case of reduced head as the result of an attempted test. (4) If, however, there is in this case considerable lateral waste in the upper strata, the valuable flow from A will be lost, just as before the test was made, while B may give a rise in the tube, or even a flow, which would foster the impression that a fair test had been made, while in reality the greater flow has been lost. (5) A gives a feebler flow than B, but has an equal head, the test will fail of being completely satisfactory only in excluding the feebler flow from A. (6) If, however, A has a lower head, and is a possible means of escape for the flowage from B, then the packing has been placed at the right point, and the test gives the best results.

FIG. 13.—Section of well, illustrating an inverted test for water under pressure. (After Chamberlin.)

In still another case, let A and B represent porous beds (figure [14]) the lower of which is so conditioned as to drain the upper one by virtue of a lower outcrop, in the manner previously explained and illustrated in figures [13 and 14]. (1) First, if the drainage-loss below is not complete, and if the packing is placed above A, as shown in figure [14], I, the result will be negative, if there is no leakage in the upper strata. (2) Should there be considerable loss there it will be cut off by the tube and packing, and some rise in the tube will be the result in most cases. In either instance the result is misleading, particularly in the last, because the small rise of the water is apt to allay any suspicion as to the effectiveness of the test. The real fact, however, remains that the flow from the productive stratum is mainly lost below. (3) Suppose that the packing is located between A and B, as in figure [14], II, it will then shut off the flow from A, while that in B, because of a lower outlet, will fail to flow. Now, if there is opportunity for lateral leakage in the upper strata the water from A will rise in the well *outside* of the test-pipe and pass off into these open upper beds. (4) But if no such opportunity is afforded it may rise to the surface and overflow *outside* of the test-pipe, while the water within the test-pipe will probably be found to be lower than

before the test was made. The proper method of testing wells known or suspected to present these conditions is to sink a simple bag of seed or other obstruction to a point in the impervious stratum between A and B, which, when it tightens in its place, will shut off the flow below. Then a tube with packing sunk to a point above A will effectually cut off all leakage in the upper strata, and the full capacity of the water-bed A will be tested.

These examples, while not exhaustive of possible cases, illustrate the nature of defective tests and the deceptive conclusions liable to be drawn from them. The remedy is manifest. Test each water-bearing stratum as it is encountered, or else vary the final tests so as effectually to exclude all liabilities to error.

To test the pressure of the water in an artesian well and thus learn the *artesian head*, a tube open at its upper extremity may be attached to the top of the casing, or of a pipe inserted in the well and provided with a seed bag at the proper place, and carried up until the water no longer overflows. For this purpose a rubber hose pipe can frequently be used to advantage. The height to which the water will rise in the tube will show the horizon below which other wells in the same artesian basin may be expected to yield a surface flow. The

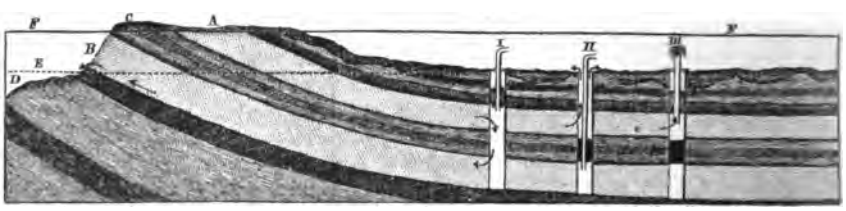

FIG. 14.—Section showing one correct and two erroneous tests for water under pressure. These wells are assumed to be independent of one another, and are placed together on the diagram merely for convenience. (After Chamberlin.)

same result can be reached by attaching an ordinary steam gage to the top of the casing and reading the pressure. Each pound of pressure per square inch will be equal to a rise of water in an open tube to the height of 2.31 feet.

The writer wishes to emphasize a few principles which evidently are not fully appreciated by all of those interested in the drilled wells of the Nez Perce region.

(1) All wells should be thoroughly tested in one or more of the ways just described, to ascertain the pressure of the water at various horizons, and if sufficient pressure is discovered at any horizon to force the water to the surface the well above that point should be effectively cased.

(2) When flowing water is obtained the well should be *securely closed at all times when the water is not being used.* The reason for this is that every flowing well is an opening into a reservoir which is *not* inexhaustible.

(3) Wells which for any reason are abandoned should be closed just above the water-bearing stratum, so as to prevent leakage into other porous layers or through fissures. This can be accomplished by

lowering a closely fitting plug of wood, about 10 feet in length, to the proper horizon. The swelling of the wood on absorbing the water will close the opening. Possibly a more satisfactory way would be to fill the boring with Portland cement. This matter is so important that it should be made a law applicable to every artesian basin. To demonstrate the importance of this measure it is but necessary to consider the wells in Tammany Hollow and at Denver, which either are not cased or are imperfectly cased and in which water rises to a definite horizon and in some instances remains at that level even when active pumping has been maintained for a long time. Such wells are in reality flowing wells, although the escape is subterranean, and are in each case reducing the pressure in the supplying stratum.

ECONOMIC GEOLOGY.

From the hasty reconnaissance on which this report is based it is not safe to venture far in reference to the economic value of the mineral resources of the region. A few notes, however, in this connection may be of some service when a more thorough geologic survey is undertaken.

BUILDING STONE.

A fine-grained, gray granite (diorite) of excellent quality occurs in practically unlimited quantity on Snake River, about 6 or 8 miles above the mouth of Grande Ronde River, and has been quarried in a small way at two or three localities. The excavations thus far made are not sufficient to demonstrate the full value of the quarries, but they indicate that large-sized blocks of homogeneous stone can probably be obtained. The localities referred to are on each side of the river, close to its margin; they are favorably located in reference to water transportation, and it is safe to predict that this beautiful granite will furnish the basis for an extensive industry in the near future.

A somewhat coarse-grained diorite, or what in commercial circles would be termed granite, occurs on Mission Creek, where it cuts through Craig Mountain, and also near Kippen. Judging from the outcrop, a good building stone might be obtained at these localities should a demand occur which would counterbalance the difficulties of transportation.

Diorite similar to that on Mission Creek occurs in vast quantities in Clearwater Canyon, from near Orofino to above Kamiah, and, as shown in several railroad cuts, an unlimited quantity of excellent stone for all kinds of rough masonry can easily be obtained. At all of the localities examined the rock is much broken by joints and is traversed by veins, so that uniform blocks of large size could not economically be quarried. This region demands careful study, however, for the conditions pertaining to transportation are favorable, and rock of uniform

grade suitable for architectural and monumental purposes is likely to be discovered.

True granite is abundant in the central part of the Bitterroot Mountains, but its distance from all lines of transportation makes it at present of no commercial value.

Limestone occurs in great quantities on the borders of Snake River, from 1 to 3 miles above the mouth of Grande Ronde River, and also about 8 miles farther upstream. The value of this stone for marble has not been tested, but it certainly merits careful study. An analysis of an average sample of the rock is given in the first column of the subjoined table of analyses of limestone, which shows it to be of exceptional purity.

Limestone outcrops beneath the Columbia River lava on the right bank of Mission Creek, about a half mile above where it emerges from the deeper portion of its canyon in the Craig Mountain uplift, and also in a gulch about 1 mile to the west. Along Mission Creek, for a distance of approximately 300 feet, the limestone is admirably exposed in the precipitous canyon wall to a height of 500 feet. It is in general a hard, grayish blue rock, containing a few obscure fossils. The strike of the beds is N. 50° E. (magnetic), and the dip is eastward at an angle of from 80 to 85 degrees. Formerly it was burned in kilns, which still remain, and it is said to have yielded a good lime. The value of the stone as marble can scarcely be judged from the weathered outcrops, but its dark color would probably make the demand for it small, even if on quarrying it is found sufficiently massive to be taken out in blocks of the desired size. An analysis of a typical sample of this rock is presented in the subjoined table, which shows that, like the similar limestone in Snake River Canyon, it is of exceptional purity and will make an excellent lime, and it is all that could be desired in the production of Portland cement or for use in the manufacture of beet sugar, etc.

On the left bank of Mission Creek, opposite the outcrop just described, a landslide has brought down basalt from above and concealed the limestone which normally should appear there. Visitors to this locality will no doubt be interested in observing the manner in which the landslide has caused the stream to be turned aside from a formerly more direct course and made to cut into its right bank, thus removing some of the débris that once concealed a portion of the limestone and making it more available for quarrying. The surface of the fallen mass forms an irregular terrace at an elevation of about 500 feet above the stream. The surface of this terrace presents a good illustration, on a small scale, of landslide topography.

Limestone occurs also at Orofino and at three or four localities on Orofino Creek within the first mile above its mouth, as well as on the southern side of Clearwater River about a half mile below Orofino. At each of these localities the well-defined beds are associated with

schist; they strike about north-south, and stand nearly vertical. The limestone has been metamorphosed, and is now mostly a coarsely crystalline marble, varying in color from white to gray. It is susceptible of a high polish, and should find a ready market for building and monumental purposes, provided it can be had in blocks of the desired size. It is favorably situated for quarrying, being close to the Northern Pacific Railroad. The surface is considerably shattered, but is not deeply weathered. Whether it is sufficiently massive at a moderate depth below the surface to be of value, can only be determined by trial. A sample of the nearly white, coarse-grained marble from Orofino has been analyzed, with the results shown in the third column of the following table:

Analyses of limestones from Nez Perce County, Idaho.

[W. F. Hillebrand and George Steiger, analysts.]

Constituent.	Snake River Canyon.	Mission Creek.	Orofino.
	Per cent.	*Per cent.*	*Per cent.*
Silica (SiO_2) and insoluble materials *a*	0.39	1.19 (Silica=1.08)	0.64 (Silica=0.37)
Iron, manganese, and aluminum oxides	0.10	0.19	0.12
Calcium oxide (CaO)	55.34	54.75	51.96
Magnesium oxide (MgO)	0.10	0.51	3.05
Carbon dioxide (CO_2), calculated	43.59	43.50	44.08
Organic matter	.....	Strong trace.	Trace.
	.....	100.14	99.85
Calcium carbonate ($CaCO_3$) *b*	98.83	97.69	92.71
Magnesium carbonate ($MgCO_3$) *b*	0.21	1.07	6.38

a The insoluble portions in analyses Nos. 2 and 3 contained a trace of titanium oxide (TiO_2).
b The amount of carbonates calculated are a trifle too high if the silica found was originally in combination with some of the dissolved lime and magnesia.

The analysis of Snake River limestone is by Steiger; the others are by Hillebrand.

The limestones from Snake River Canyon and Mission Creek are exceptionally pure and are suitable for use in the manufacture of Portland cement, in the beet-sugar industry, etc. The limestone at Orofino evidently would make a good lime if properly calcined, but it is not desirable for the other purposes mentioned, on account of the magnesium present. There are, however, several beds of limestone near Orofino, a careful study of each of which would very likely reveal the presence of material as rich in calcium carbonate and as free from impurities as the limestone from Mission Creek and Snake River Canyon.

Basalt (lava) is everywhere abundant in the Nez Perce region to the west of the foothills of the Bitterroot Mountains, and generally throughout central and eastern Washington and Oregon. Its somber color makes it objectionable for most architectural purposes, except for the foundations of buildings, bridges, etc., but in many cities similar rock has been used for entire buildings. Its chief use should be for

road material, to which purpose it is well adapted. It is hoped that the time will soon come when the poor roads of the region occupied by the Columbia River lava will be improved by macadamizing them.

The volcanic dust interbedded with the Columbia River lava on Captain John and Asotin creeks has been used for the walls of a bank building in Lewiston, and has the advantage of being easily worked and of a desirable color. It is doubtful, however, whether the use of this stone for outside walls should be encouraged; but for interior walls, especially of fireproof buildings, it has decided advantages over most other stones. It would be interesting to experiment with this dust, in connection with Portland cement, in the manufacture of artificial stone, and also to test its desirability as an ingredient of friction soap. The finer grades, when well sifted, make a good polishing powder.

Slate of a pleasing reddish color, of easy cleavage, and, so far as can be judged from natural exposures, of good quality, occurs on the eastern side of Cottonwood Butte, and is well located for quarrying. This material should be thoroughly tested as soon as transportation facilities admit of its being put on the market, to ascertain whether sheets of the desired size can be obtained.

LIGNITE.

In the sedimentary beds interstratified with the Columbia River lava lignite has been discovered at several localities. On the southern side of Clearwater River a half mile below Orofino openings have been made in the side of the canyon, on the farm of F. M. Holt, at an elevation of about 200 feet above the river, which reveal the following section:

Section on Clearwater River one-half mile below Orofino.

	Feet.
Talus, from slopes above	
Sandstone, coarse	2.0
Slate, fine, sandy	0.8
Lignite, with branches of trees	0.2 to 0.5
Sandstone	2.5
Lignite	0.2 to 0.4
Sandstone	5.0
Lignite	1.7
Sandstone, bottom not seen	1.0
Talus to the river bank	

The beds are well exposed in the openings that have been made, one of them being a tunnel about 40 feet in length, but the material is part of a series of landslides, and the true position of the lignite should be sought about 500 feet higher than where it is now to be seen. The prospecting that has been done serves to indicate that a bed of lignite exists beneath the neighboring plateau, but there is no

reason for doing further work at the locality where openings have already been made.

Lignite is reported to occur at several localities on Orofino Creek (all of it probably belonging to approximately the same bed), within a distance of several miles in the middle portion of its course. The only one of these outcrops that was examined by the writer is situated on the immediate banks and in the bed of the creek about 15 miles above its mouth (sec. 12, T. 36, R. 4), but is not in place. As already explained, vast numbers of landslides have occurred on each side of the canyon of Orofino Creek throughout its entire length in the Columbia River lava. The number and large size of these slides is evidence of the presence of a thick layer of soft material beneath the upper sheet (or sheets) of the lava which forms the surface of the adjacent plateaus. On the left bank of the creek, at the locality referred to, and partially submerged, the following section is exposed, the dip being south at an angle of 30 degrees and the strike about east-west, or with the course of the stream:

Section on Orofino Creek about 15 miles above mouth.

	Inches.
Sandstone, gray, with fossil leaves	12.0
Lignite	20.0
Clay parting	2.5
Sandstone, base not exposed	6.0

These outcrops can be followed along the bank of the creek and in its bottom for a distance of 60 to 70 feet. Near the upstream end of this natural exposure, on the north side of the creek and at the water's edge during low-water stages, a prospect shaft about 15 feet deep has been opened. In this shaft the strata where first met, beneath a foot or two of surface débris, are nearly vertical, but below they dip northward and soon flatten, until the inclination is about 50 degrees. The lignite is 27 inches thick, and has fine micaceous clay on its southern side and a coarse sandstone on its northern side. The lignite-bearing formation on the two sides of the creek is a portion of a sharp upward fold or anticline, which is broken along its crest, where the creek now flows. This fold is obviously due to the weight of the landslides on each side, and is not a structural feature of the beds in place.

The true position of the lignite in the canyon walls is not known, but should be looked for at an elevation of between 400 and 600 feet above the creek. The lignite-bearing rocks no doubt underlie a wide extent of the adjacent plateaus.

The most satisfactory way in which to prospect for the lignite would be to put down drill holes on the plateaus, where the formations are undisturbed, unless a locality can be found along the borders of Orofino Canyon or its branches where the all-prevailing talus and displaced masses leave the sedimentary beds exposed.

Lignite is reported to occur at several localities in the bed of Orofino Creek above the exposure just described. It is doubtful, however, whether any of these outcrops are in place, but they should indicate the value of the deposits beneath the adjacent plateaus. It is also reported to exist at several places in Little Canyon, to the south of Orofino. One of these outcrops, near Russel, which was examined by the writer, is at the bottom of the canyon, which there is 800 feet deep and has precipitous walls composed of horizontally bedded lava sheets. Throughout the portion of the canyon seen there is a notable absence of conspicuous landslides, from which fact, and from the abundant exposures of the edges of lava sheets, it is to be inferred that sedimentary beds at a higher level than those in the bottom of the canyon, described below, are either absent or are of small thickness. On each side of the canyon at the locality referred to near Russel, where a lateral canyon joins it from the eastward, and on the border of the tributary brook, the following section was exposed by a recent excavation:

Section in Little Canyon, near Russel, Idaho.

	Inches.
Talus, fallen from above	75.0
Carbonaceous shale, apparantly altered by heat	41.0
Parting of white laminated shale composed in part of volcanic dust	1.0
Black carbonaceous shale	2.5
White "shale"	1.5
Black carbonaceous shale	6.0
White laminated shale[1]	10.0
Coarse sandstone with fragments of shale, base not exposed	36.0
Total, about ... feet	14.5

The carbonaceous shale reported in the section, although probably mistaken for lignite, or "coal," by the parties who prospected it, is much too earthy to pass for that material, and is probably of no economic value. Although no lignite was seen by the writer, and none has certainly been discovered in Little Canyon, the presence of carbonaceous shale, sandstone, etc., at about the horizon at which the lignite near Orofino probably belongs, is sufficient encouragement to warrant the sinking of a prospecting shaft at the locality described. Equally favorable sites for prospecting no doubt occur at other places in Little Canyon, and probably also in Big Canyon. In making such a test as suggested, the talus should be cleared away from the base of the cliffs, so as to expose the contact of the sedimentary beds with the basalt above, and a shaft be sunk at a locality where it would not be

[1] The peculiar, evenly laminated white "shale" is composed in part of volcanic dust, and is crossed by irregular and in places vertical fissures which are filled with a dark material, probably once a soft mud, containing fragments of both sedimentary and volcanic origin. Similar débris-filled fissures were observed in the beds of fine white volcanic dust exposed in Potlatch Canyon.

flooded during high water. The shaft should be continued through the sedimentary beds and at least a few feet into the basalt beneath. A single shaft, however, would not be sufficient to determine the value of the field over a large area, as it is possible that the lignite occurs in more or less detached lenticular bodies, each one representing the vegetable matter accumulated in an old swamp.

Lignite is reported to occur at a few other localities in the lava-covered portion of Nez Perce County, as, for example, on Captain John Creek; but these places were not visited during the reconnaissance. It has also been discovered on the southern side of the Blue Hills in Washington—on the slopes leading down to Grande Ronde River, about 20 miles from the mouth of that river. The openings in lignite which have been made are on S. P. McNeil's land and neighboring ranches, but other outcrops are said to occur on each side of the canyon in this region throughout a distance of several miles. The northern side of the canyon, as already described, is encumbered with landslides, and a very large part of the secondary topographic features are due to this cause. The marked prevalence of landslides and the large size of some of the displaced rock masses are strong evidence of the presence of thick layers of soft material between the conspicuous lava sheets. The indications of the presence of sedimentary beds which are furnished by the topography are confirmed by known outcrops of sandstone, lignite, clay, volcanic dust, etc. All of the exposures of lignite observed by the writer are on or near Mr. McNeil's ranch. At one locality a tunnel about 125 feet long has been excavated, all of it in lignite. Near the inner end of this tunnel a thickness of 9 feet of lignite, practically without partings, was measured, but neither its upper nor lower surface was exposed.[1] Well within the tunnel the dip is northward at an angle of 2 to 2½ degrees. In another excavation, about 2 miles east of the one just referred to, a thickness of 16 feet of lignite is reported to occur, and there seems no reason to doubt the accuracy of the observation.

All of the facts learned by the writer pertaining to the lignite in the canyon of Grande Ronde River are in harmony with the idea that the openings thus far made in it are in landslides, and that the true position of the beds, or where they occur in place, is 200 or 300 feet below the summit of the canyon walls. From the facts in hand it seems evident that the thickness of the lignite where openings have been made in it is abnormal and does not represent the thickness that will be found where the beds are discovered in place. As is well known, a mass of rock descending in a landslide accumulates material beneath it, along its lower margin, and on coming to rest almost invariably has a back-

[1] The writer has been informed by Mr. E. W. Barnes, of Portland, Oregon, under date of January 9, 1901, that since the visit to the tunnel during the reconnaissance it has been extended about 25 feet, and a winze has been sunk at its end to a depth of 25 feet from the roof of the tunnel, all in lignite, with the exception of a few thin partings. The writer understands, however, that even these recent excavations failed to reveal the full thickness of the lignite.

ward dip, or is inclined downward toward the cliff from which it broke away. In the tunnel referred to the dip is northward, but the downward inclination of the rocks in place in that region should be southward, as previously explained. The lignite and its accompanying beds of sedimentary material and volcanic dust appear to have been sheared and overthrust, owing to the weight and motion of the overlying basalt, which descended with them. For this reason they exhibit a greater thickness than should be assigned to them in estimating their commercial value.

While the bodies of lignite in some of the landslides are no doubt of sufficient size to be of value, no great areas are to be expected. The present excavations are sufficient to demonstrate the quality of the material so far as the beds exposed are concerned, and if this is found to be satisfactory, future prospecting, with the view to discovering the beds in place, is justifiable.[1]

The discovery of the lignite in place should not be a difficult matter. After traveling over the slopes where landslides are prevalent, and becoming familiar with the characteristic features in the relief produced by them, a wide-reaching view of the canyon walls, such as can be obtained from almost any eminence in the region, will enable one to determine the localities where the rocks are still in place. These areas will usually be found to be bounded by cliffs from which landslides have fallen, and the removal from the bases of these cliffs of the all-prevailing surface débris should reveal the sedimentary beds carrying the lignite. A shaft sunk at the margin of such an escarpment should be carried down to the next sheet of basalt, and would reveal such lignite beds as may be present. The test should not be abandoned in case a lignite seam is found which is too thin to be worked to advantage, for other seams may occur below it. The lignite layers no doubt vary in thickness from place to place, and a thin seam discovered in one shaft may be found to thicken at a neighboring locality. Probably the localities where the lignite can most

[1] Mr. E. W. Barnes, of Portland, Oregon, has kindly furnished the following analyses of samples of lignite from the locality described, which were collected by himself. The analyses were made at the Montana Metallurgical Works, Portland, Oregon, J. T. Gove, manager.

Analyses of lignite from Grande Ronde River, Washington.

Constituent.	Sample No. 1.	Sample No. 2.
	Per cent.	*Per cent.*
Moisture	20.50	6.50
Volatile combustible matter	40.75	38.50
Fixed carbon	31.25	42.00
Ash	7.50	13.00
Total	100.00	100.00

If sample No. 1 fairly represents the beds described, it is evident they are of commercial importance. It is desirable, however, to have tests made of the heating properties of the lignite on a large scale before forming a positive opinion as to its value.

easily be found in place are in the cliffs on the south side of the river, 200 or 300 feet below their summits; but a mine developed there will have to follow a seam which is dipping southward, or away from the mouth of a tunnel begun at the outcrop, and in general would be more difficult to drain than a mine on the north side of the river, where the dip would favor both drainage and the removal of the lignite. The most favorable location on the south side of the river would be near the head of a lateral canyon, for at such a locality a tunnel could be run approximately parallel with the strike of the beds, thus insuring drainage for lateral tunnels which might be directed up the slope.

In most instances the lignite retains its woody structure, and looks very like the wood derived from modern peat swamps. Its color is black when wet, and except when composed largely of trunks and branches of trees is nearly black when dry. It exfoliates and crumbles rapidly when exposed to the air. The woody portions when dry have a rich brown color and clearly show their structure. It can not be termed coal, and is apparently a rather poor quality of lignite. These statements apply to the lignite, so far as the writer has seen it, at all of the openings made in it in the Nez Perce region, except the one on Orofino Creek, where kernels and irregular masses, an inch or more across, of yellow resin but little altered from its original condition are conspicuous in certain portions of the deposit. Small specimens of lignite "float," said to have been found in the canyon of the North Fork of Clearwater River in the vicinity of Elk Creek, and other similar fragments from Orofino Creek are jet black in color, and evidently are of much better quality than any of the material thus far obtained at the localities described.

GOLD, SILVER, AND COPPER.

To the reader who is not familiar with the mineral resources of the Nez Perce region it may be of interest to learn that the crystalline rocks of older date than the Columbia River lava are quite generally ore bearing. These rocks in many instances are metamorphic in character; that is, they consist of either sedimentary or igneous material that has been greatly altered by heat and pressure and by movements which have caused it to become sheared and assume a schistose structure. Besides these changes there have been great intrusions of molten magmas, either into fissures, as in the formation of the numerous dikes, or of a regional character, as the intrusion of granite, diorite, etc., into the earth's crust from great depths below the surface. Where either the metamorphic or plutonic rocks are exposed at the surface it is manifest there has been deep erosion. The thickness of rock removed has not been measured, but may safely be estimated at several thousand feet. The rocks which once were deeply buried are frequently traversed by veins in which more or less metallic material,

in the form of free gold or of ores of silver, copper, etc., has been deposited from the heated waters which percolated through them.

In general the rocks exposed beneath the Columbia River lava in the canyons of Snake, Salmon, and Clearwater rivers are such as are looked to for deposits of gold, silver, copper, and many other ores and minerals. The prediction which a geologist would be led to make from the general character of these rocks is that they will be found to contain the precious metals, which is verified by the discovery of gold and of ores of silver and copper in what are reported to be rich deposits. Several gold mines are being worked to the east of the margin of the Columbia River lava, and hundreds of promising prospects are reported in the same rugged country. The most productive gold-bearing quartz mines in the region shown on the map forming Pl. II are in its northeastern portion, in the Mascot Hills; but similar conditions exist as far south as Mount Idaho. Just what the future of these gold mines will be no one can tell, but the superficial examination which the writer was enabled to make failed to indicate great possibilities. The rocks contain numerous small gash veins, consisting of quartz which has been deposited from solution and containing mineral matter derived from the adjacent country rock; but they did not reveal the presence of any true lodes or fissure veins. The small veins are frequently rich and serve to stimulate prospecting, but the chances of discovering a bonanza are meager.

The great amount of erosion referred to, which has led to the exposure of the vein-bearing rocks now occupying the surface, was accomplished by the crumbling and decay of a vast amount of rock similar to that now in sight. The removal of this material by streams resulted in its being assorted, the gold which it contained being concentrated on their beds. In this manner the bottoms of all of the streams flowing away from the mountains of old crystalline rock became charged with alluvial or placer gold. Gold is now obtained by washing the gravel along Snake, Salmon, and Clearwater rivers, and the total amount collected each year is considerable. The gold along the main streams and in the gravel forming their abandoned flood plains is nearly all fine, so fine, in fact, that in most instances a portion only of it can be saved by any known method of placer mining. Along some of the smaller streams tributary to Clearwater River rich placers of coarse gold have been discovered. The most productive of these are just above the margin of the Columbia River lava; but they have now been worked out and abandoned. Rich copper ores are obtained in the side of the canyon of Snake River above the mouth of Grande Ronde River, and important developments in that field are to be expected.

To the reader who has labored for years with pick and shovel in searching for treasures in the Nez Perce region the writer has but one suggestion to offer. In a preceding paragraph attention was

directed to the well-known process by which rocks are disintegrated and the gold which they contain is concentrated in stream beds. As this process was in action long before the coming to the surface of the Columbia River lava, it is evident that the stream channels beneath the lava should contain gold. The exceedingly rich placers on Cow, Reid, and other creeks on the border of the Mascot Hills occurred in gulches just above the margin of the lava, and but little gold has been obtained from above the lava itself. One reason for this is that the streams from the uplands of old crystalline rock experience a sudden change in gradient on meeting the level lava sheets, being swift in the older portions of their channels and sluggish where they flow across the lava to the head of a canyon cut in it. Under these conditions the greater portion of the gold—in fact, all except possibly the thinnest flakes—brought down by the streams from their swifter upper courses would be deposited where the change in gradient occurs. But the streams were carrying gold before the lava interrupted their flow, and the portions of their beds beneath the lava should contain the yellow metal. These old channels should be searched for. They may not be directly beneath the present streams, but may open into the canyons cut in the lava from the side, and possibly be a mile or two below where a stream makes its plunge into the canyoned portion of its course. The sides of the canyons are encumbered with talus and landslides, but excavations made where this material is thin should reveal the buried gravel, which might repay washing, and tunnels opened in it and beneath the lava covering would afford means of getting rid of the débris, so that the deposits on the surface could be worked. The possibilities of finding gold-bearing gravel beneath the Columbia River lava or interbedded with it are such that the contact of the lava with the underlying formations exposed along Snake, Salmon, and Clearwater rivers should be carefully searched.

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APPENDIX A.

ELEVATIONS IN NEZ PERCE REGION.

The following elevations are from surveys made by the Northern Pacific Railway Company, and have been furnished by Mr. E. H. McIlenry, chief engineer. In each case they were taken either at the top of the tie opposite the center of the depot, or, where depots have not been constructed, at the center of sidings, and are from profile elevations reduced to sea level:

Elevations by Northern Pacific Railway Company.

	Feet.
Agatha (side track)	908.0
Ahsahka (side track)	1,002.0
Basalt (side track)	855.6
Caldwells spur	1,265.8
Cul de Sac spur	1,616.8
Juliaetta (depot)	1,084.0
Kamiah (depot)	1,197.8
Kooskia (side track)	1,263.0
Lenore (depot)	923.0
Lewiston (depot)	739.8
North Lapwai (depot)	809.0
Orofino (depot)	1,028.0
Peck (depot)	963.0
Potlatch (depot)	829.0
Stiles (side track)	1,320.0
Sweetwater (depot)	1,102.0
Weippe (side track)	1,088.8

The following elevations are from surveys made by the Oregon Railway and Navigation Company, and are above sea level:

Elevations by Oregon Railway and Navigation Company.

	Feet.
Top of State line monument on north bank of Clearwater River, at its mouth, near Lewiston	757.93
High-water mark at junction of Snake and Grande Ronde rivers	842.3
High-water mark on Snake River at boundary between Oregon and Washington	886.0
High-water mark at junction of Snake and Salmon rivers	965.0
High-water mark at Douglas, 57 miles above Lewiston	1,012.0

NOTE.—The elevations given in the body of this report are from aneroid measurements, which frequently could not be checked by comparison with definite bench marks, and must be taken simply as approximations to the actual heights of the localities mentioned.

APPENDIX B.

NOTES CONCERNING PORTLAND CEMENT.

Portland cement is an artificially prepared substance which has the property of hardening in the air when mixed with a suitable proportion of water, and of remaining hard when immersed in water. Its value lies in the fact that when used in masonry it produces a strong bond which does not weaken when submerged in water or exposed to a damp atmosphere. In its manufacture an intimate mechanical mixture of finely pulverized limestone, or marl, and clay is "burned" at a high temperature, and the resulting "clinker" is ground to a fine powder. The finished cement does not necessarily have a fixed and definite composition, but considerable variation may occur and an excellent product still be obtained. The degree of variation in composition usually considered allowable is indicated in the first column of the subjoined table. As is shown by the permissible variation in its finished product, there is considerable latitude allowable in selecting the raw material; but the limestone and clay need to supplement each other, so that when mixed in the proper proportions the resulting "slurry," as such a mixture is termed before being burned, will not vary in chemical composition beyond the approximate limits indicated in the second column of the following table:

Analyses showing permissible variations in the composition of Portland cement and in the slurry from which it is made.[1]

Constituent.	Permissible variation.	
	Portland cement.	Slurry.
	Per cent.	*Per cent.*
Silica (SiO_2)	20 to 24	12.68 to 15.22
Alumina (Al_2O_3)	6 to 10	3.80 to 6.34
Ferric oxide (Fe_2O_3)	3 to 5	1.90 to 3.17
Calcium oxide (CaO)	60 to 64	38.04 to 40.58
Magnesium oxide (MgO)	1 to 3.5	0.65 to 2.25
Sulphuric anhydride (SO_3)	0.5 to 0.7	0.35 to 1.25

In the following table analyses are presented of the limestone, marl, clay, and shale used in the manufacture of some of the standard

[1] The writer is indebted to Prof. E. D. Campbell, of the University of Michigan, for the data herewith presented.

brands of Portland cement, or that have furnished satisfactory results in the making of small samples of cement in the laboratory:

Analyses of raw materials used in making Portland cement.

Constituent.	Limestone.		Marl.		Clay.		Shale.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silica (SiO_2)	3.53	2.14	0.52	0.20	59.15	61.68	65.25	49.93
Alumina (Al_2O_3)	1.14	1.46	0.51	0.50	19.85	19.60	21.06	25.33
Ferric oxide (Fe_2O_3)			0.53	0.60	8.30	3.12	3.40	6.05
Calcium oxide (CaO)	54.45	52.84	51.66	50.12	3.03	2.40	0.84	3.12
Magnesium oxide (MgO)	0.44	1.04	1.37	0.83	1.36	1.77	1.78	1.65
Sulphuric anhydride (SO_3)	.....	.....	0.89	0.56	.....	0.43	.....	0.38
Loss on ignition	38.74	42.52	44.52	47.19	8.02	7.18	6.10	10.19
	98.30	100.00	100.00	100.00	99.71	96.18	98.43	96.65
Calcium carbonate ($CaCO_3$), computed	97.23	94.35	92.25	89.50	.....	.....	.....	.....
Magnesium carbonate ($MgCO_3$), computed	0.92	2.18	2.87	1.74	.....	.....	.....	.....

The foregoing analyses indicate the range in chemical composition which limestone (or marl) and clay (or shale) should have to be worth further investigation in reference to their use in the manufacture of Portland cement. A study of these data will show that the material to be used must be as free as possible from sulphur, the greatest amount of sulphuric anhydride (SO_3) permissible in the slurry being about 1 per cent, but, preferably, it should be below 0.5 per cent, and the magnesia also should be low, the greatest amount permissible under present American practice being about 3.5 per cent, although its influence on the properties of the finished cement is still under investigation. (Dyckerhoff, an eminent German authority on Portland cement, gives 4 per cent as the maximum for magnesia.) Other substances that frequently are present in the materials mentioned have in general but little deleterious influence, and may be considered adulterants. A general rule is that the sum of the ferric oxide and alumina in the slurry shall be about one-third of the amount of silica present.

In addition to the chemical composition of the raw materials it is desirable that they shall have certain physical properties. Chief among these there should be an absence of sand, for the reason that if the silica is in the form of quartz grains or kernels it will not unite with the lime in the desired manner when the slurry is burned; and the silica should be *combined silica*, as, for example, the aluminum silicate of clay. Both the limestone and the clay should be of such consistency that they may readily be reduced to a fine powder. The ideal lime ingredient is a soft, incoherent, fine marl, but if a limestone is used it is desirable that it be soft, so that the expense of grinding it to a fine powder may be reduced to a minimum. Still certain hard limestones are used, and the only objection to them, in case they have the requisite chemical composition, is the expense of grinding. The most desirable clay is one free from sand, which, when agitated in

water, will readily separate into fine particles. The best clays for this purpose are those having a greasy, unctious feel, and which are smooth to the touch. Hardened clay or shale is also used, but it has to be ground before being mixed with the lime to form slurry. It is highly desirable that the deposits both of lime and clay be of uniform chemical and mechanical composition throughout, in order to avoid trouble in combining them in the correct proportions.

In addition to the raw materials which enter directly into the composition of Portland cement, fuel is necessary for burning them. For this purpose, in the rotary kilns now generally used in this country, gas, petroleum, or pulverized coal is used. If coal is employed, it should be high in volatile matter, free or nearly free from sulphur, and low in ash, for the reason that it comes in direct contact with the cement-producing materials and influences the composition of the resulting product. The coal used by the Omega Portland Cement Company, of Michigan, has the following composition:

Analysis of coal used in manufacture of Portland cement.

	Per cent.
Moisture	1.00
Volatile matter	39.37
Fixed carbon	55.82
Ash	3.81
Total	100.00
Sulphur	0.92

The coal is pulverized so that it will pass through a sieve having 100 meshes to the line or inch, and is blown, by means of hot air, into the rotary kiln, where it burns, producing a long jet of flame.

In reference to the establishment of a Portland-cement industry in the Nez Perce region, it will be seen from the analyses of limestones presented that some of them at least have the desired chemical composition. The limestones on Mission Creek and that occurring in Snake River Canyon, for example, are of exceptional purity and well suited to this use. But the rock is hard, and could not compete commercially with a softer rock of equally favorable composition, provided the cost of transportation, etc., were the same.

The analyses of the ordinary soil and subsoil of the wheat lands show that they should be experimented with to determine their value as the "clay" ingredient of Portland cement. The doubtful feature is the comparatively high percentage of alkalies present, that is, potash and soda. This would tend to make the slurry easy to burn and to produce a quick-setting cement; but its influence can only be determined by actual trials. Small samples of cement could be made in the laboratory, and the behavior of the materials chosen thus be definitely ascertained. The writer suggests that a typical sample of the subsoil of the wheat lands, mixed in the requisite proportion

with the limestone that occurs on Mission Creek or in Snake River Canyon and properly burned, might yield a good Portland cement. The experiment is well worth trying. The soil of the wheat lands has in places been removed by streams and redeposited. This washed soil may be expected to be less rich in alkalies than the original material, and it might serve the purpose suggested, in case the soil occurring in place is found to be too high in potash and soda. The beds of clay interstratified with the Columbia River lava should also be tested.

Regarding fuel, the lignite occurring on Grande Ronde River and elsewhere might, perhaps, if finely powdered, answer the purpose. If not, the next most convenient source of supply would be the coal mines at Roslyn and Clealum, Washington. A commercial analysis of the Grande Ronde lignite has been given on a former page. Commercial analyses of the Roslyn and Clealum lignites, made by W. S. Thomas, of the Castner Coal and Coke Company, of Belt, Montana, are as follows:

Analyses of lignite from Roslyn and Clealum, Washington.

Constituent.	Clealum.	Roslyn.
	Per cent.	*Per cent.*
Moisture	5.55	2.16
Volatile matter	36.75	36.95
Fixed carbon	50.20	46.90
Ash	7.50	14.10
Sulphur	0.59	0.39

How the samples analyzed were taken is not known to the writer, and whether these analyses fairly represent the composition of the lignite at the respective localities can not be stated. It is doubtful, however, whether the average Roslyn lignite is as high in ash as is here stated.

In reference to the location of a Portland-cement plant, the chief consideration is transportation. As from three to five times as much limestone as clay is required, it usually follows that it is most economical to locate the plant near the source of the limestone; but the carrying of fuel must also be taken into account, as well as the direction of the market for the finished product.

On the whole, the conditions favorable to the establishment of a Portland-cement industry in the Nez Perce region are such that the matter deserves careful study.

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DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 55

GEOLOGY AND WATER RESOURCES OF A PORTION OF YAKIMA COUNTY, WASH.—SMITH

WASHINGTON
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1901

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND WATER RESOURCES

OF

A PORTION OF YAKIMA COUNTY, WASH.

BY

GEORGE OTIS SMITH

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, April 1, 1901.

SIR: I have the honor to transmit herewith a paper entitled Geology and Water Resources of a Portion of Yakima County, Wash., by George Otis Smith, and to recommend that it be published in the series of pamphlets on water supply and irrigation. Mr. Smith has, in connection with his studies of the geology of the vicinity of North Yakima and Ellensburg, familiarized himself with the geology of this region, and in the above-described paper has given special attention to the artesian development of the Yakima Valley. In Bulletin No. 108, by Prof. I. C. Russell, published in 1893, there will be found a description of the geologic structure adjacent to the drainage basin of Yakima River, giving special attention to the occurrence of artesian wells. Professor Russell continued his studies in 1896, and the results were published in Water-Supply Paper No. 4, entitled A Reconnoissance in Southeastern Washington. Mr. Smith, after a more detailed investigation, has been able to give additional facts regarding the conditions of this section.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHAS. D. WALCOTT,
Director United States Geological Survey.

GENERAL VIEW OF ATANUM MURRY VALLEY

GEOLOGY AND WATER RESOURCES OF A PORTION OF YAKIMA COUNTY, WASH.

By GEORGE OTIS SMITH.

INTRODUCTORY.

The region discussed in this report is in central Washington. It is mapped in Pl. II and in fig. 1. The area shown in Pl. II includes more than 750 square miles, but the district to which special attention is given comprises about 50 square miles in the vicinity of the city of

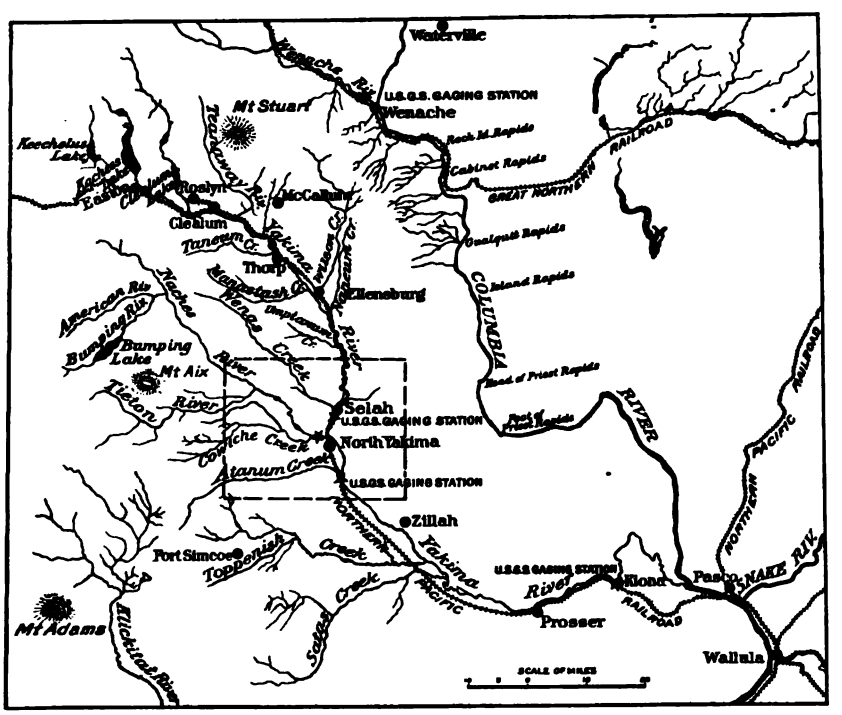

FIG. 1.—Map of central Washington.

North Yakima. The western half of the area is included in the Ellensburg quadrangle. It has been surveyed both topographically and geologically by parties from the United States Geological Survey, and a geologic atlas of the district is now in course of preparation.

The field work upon which this report is based was carried on during July and August, 1900. A reconnaissance of the same area was made eight years ago by Prof. I. C. Russell.[1] At that time, however, only a beginning had been made in the development of the artesian resources of the district, and, in addition, Professor Russell's opportunities for observation were limited by the hurried character of his reconnaissance. In the preparation of this paper the writer has had before him the report of Professor Russell's reconnaissance, and the modifications of Professor Russell's conclusions which may be proposed herein are based upon additional evidence which has been collected since that report was written.

The writer wishes to express his indebtedness to Mr. F. H. Newell, hydrographer in charge, also to Mr. Cyrus C. Babb, of the Division of Hydrography, for suggestions made in the course of the preparation of this report. In the discussion of surface waters extracts have been freely made from the reports of Mr. Newell and Mr. Babb, and some entire paragraphs have been written by the latter gentleman.

GEOGRAPHY.

TOPOGRAPHY.

In its general aspect this region resembles the Great Plains of the Columbia, except that it possesses greater topographic diversity. Broad valleys, with bounding ridges, trend east and west, or transversely to the course of Yakima River. The bold character of the canyons which this river has cut through the ridges can not fail to impress the traveler, but unless he leaves the railroad he often does not observe the broad valley stretches. The floors of the transverse valleys slope gently toward the river, and rarely are deeply scored by its tributary streams. Above these valleys the ridges rise to elevations of several thousand feet, their level-topped crests interrupted only by the deep water-gaps of Yakima River. The slopes of the ridges, except in these gaps, are gentle, and merge into the valley floor below.

The east-west ridges divide the region into convenient topographic groups, which are recognized locally. Thus the Atanum or Yakima Ridge on the south, and the Selah Ridge and Cowiche Mountain on the north, inclose the long transverse valley which east of Yakima River is known as Moxee Valley, and west of the river as Atanum Valley and Wide Hollow. North of Selah Ridge and its western continuation is the transverse depression known as Selah Valley and Wenas Valley, while south of Atanum Ridge is the broad valley known as Reservation Valley, which is in large part included within the Yakima Indian Reservation. These subdivisions of the area are geologic as well as topographic, and they will be mentioned further on.

[1] See A geological reconnoissance in central Washington, by I. C. Russell: Bull. U. S. Geol. Survey No. 108, 1893.

CLIMATE.

This region has the arid climate of the Columbia Plains. In the vicinity of North Yakima the annual rainfall averages slightly more than 8 inches, and in the eastern part of the area the precipitation is doubtless even less; but the western and higher portions share in part the climatic influence of the Cascade Range, and there the annual precipitation in the form of rain and snow is considerably greater. As an illustration of this increase, the records kept at Clealum and Ellensburg, both situated in the upper Yakima Valley, may be cited. At the former place, which is 25 miles farther up the valley, the annual precipitation is more than three times that at Ellensburg, while the latter place has a rainfall exceeding that at North Yakima, lower in the same valley. If records were available a similar increase could undoubtedly be shown in the upper portions of Atanum, Cowiche, and Wenas valleys.

The summers are hot and dry, and with the high percentage of bright, clear days are very favorable to agriculture. In the lower valleys the winters are short, and very cold weather is uncommon. The mean annual temperature in the vicinity of North Yakima is about 50° F. The record kept in the year 1895 in Moxee Valley gives the mean as 49.7° F.[1] An excellent index of the varied climate of the region is afforded by the native vegetation. Along the rivers and streams only a few trees are found, the cottonwood being abundant on the east bank of the Yakima near North Yakima, but the rest of the lower valleys, and even the ridges in the central and western portions of the area described, are treeless and of desolate appearance. Sagebrush and associated desert shrubs grow wherever the land is in its primeval state, and the nutritious bunch grass is plentiful on the ridges, except where excessive grazing has destroyed it. In the western quarter of the area mapped the yellow pine appears first in scattered single trees, and then in open groves which add much to the beauty of the scenery as one traverses the higher ridges.

SOIL.

Analyses of soil from Atanum and Wenas valleys[2] show that it is rich in potash, magnesia, lime, and phosphoric and sulphuric acids, constituents which are essential to plant life. The fine texture of the soil is a characteristic doubtless even more important than its chemical composition, for it not only facilitates cultivation, but renders soluble and available a greater percentage of the mineral matter. The aridity of the climate also doubtless has had a beneficial effect, in that the soil has not lost its most valuable constituent by the leaching of subsurface waters.

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1 First Ann. Rept. Bureau of Statistics, Agriculture and Immigration of State of Washington, 1896, p. 24.

2 Op. cit., p. 26.

In this connection it may be well to sound a word of warning against the waste of water. Excessive irrigation has already injured certain portions of the lower valleys in this county. Not only does the constant presence of water result in leaching out some of the more soluble of the valuable soil elements, but in the lower levels the action of this water is to bring to the surface certain salts that are injurious to vegetation. Such waste of water in irrigation is thus a double evil. In an irrigation district the good of the community should constantly be considered, and it is the duty of the individual to think of the future as well as the present productiveness of the soil.

AGRICULTURE.

Yakima County is preeminently an agricultural region. The valleys along Yakima River are within easy reach of the Northern Pacific Railway, which gives them ready communication with Puget Sound. The rapid growth of the trans-Pacific trade is encouraging, and can not fail to benefit the agricultural industry. The Puget Sound cities and Roslyn, a coal-mining town farther up the valley, already are important markets for the products of the Yakima region, and as the mining industry of the Cascades develops additional markets will be afforded.

These valleys are also situated close to the mountainous regions which furnish summer grazing for large herds of cattle and bands of sheep. Grazing in these mountains has often been destructive, but now, under the conservative management of the Secretary of the Interior, it is judiciously regulated. The permanence of these mountain pastures is important to the agricultural industries of the valley, for the cattle and sheep constitute a home market for much of the hay raised there, since winter feeding is necessary.

The crops that are cultivated in this district are many and varied. In the irrigated portion hay is raised which commands a higher price in the Puget Sound markets than that from any other locality. Alfalfa, clover, and timothy are the forage plants commonly grown. Of the cereals, wheat and oats are the most important. Potatoes, sweet corn, and other garden vegetables grow well in the Yakima valleys, and are readily marketed in the Sound cities. Of orchard fruits, apples, peaches, prunes, pears, cherries, and apricots grow to the highest perfection, and the fruit industry may be considered only partially developed, although its success is assured. All of the small fruits grow equally well. This region has also long been famous for the excellent quality of its hops, which crop continues to be an important one. Sorghum is raised to some extent, and as the agricultural possibilities are gradually developed, doubtless the culture of many other crops will be found to be profitable.

At a few localities dry farming has been attempted, but with little success. Wheat and barley are the crops raised where irrigation is

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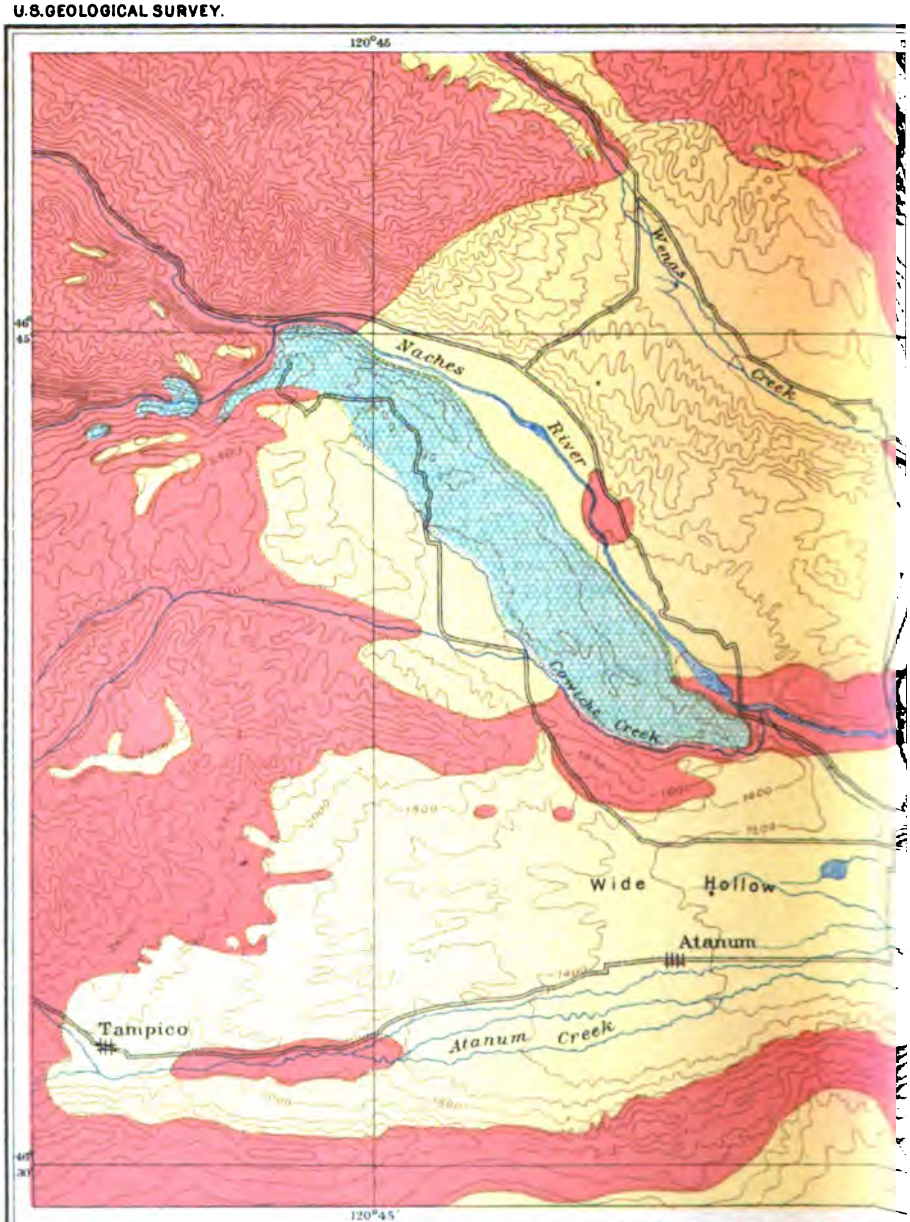

Topography by
A. E. Murlin and
Northern Transcontinental Survey

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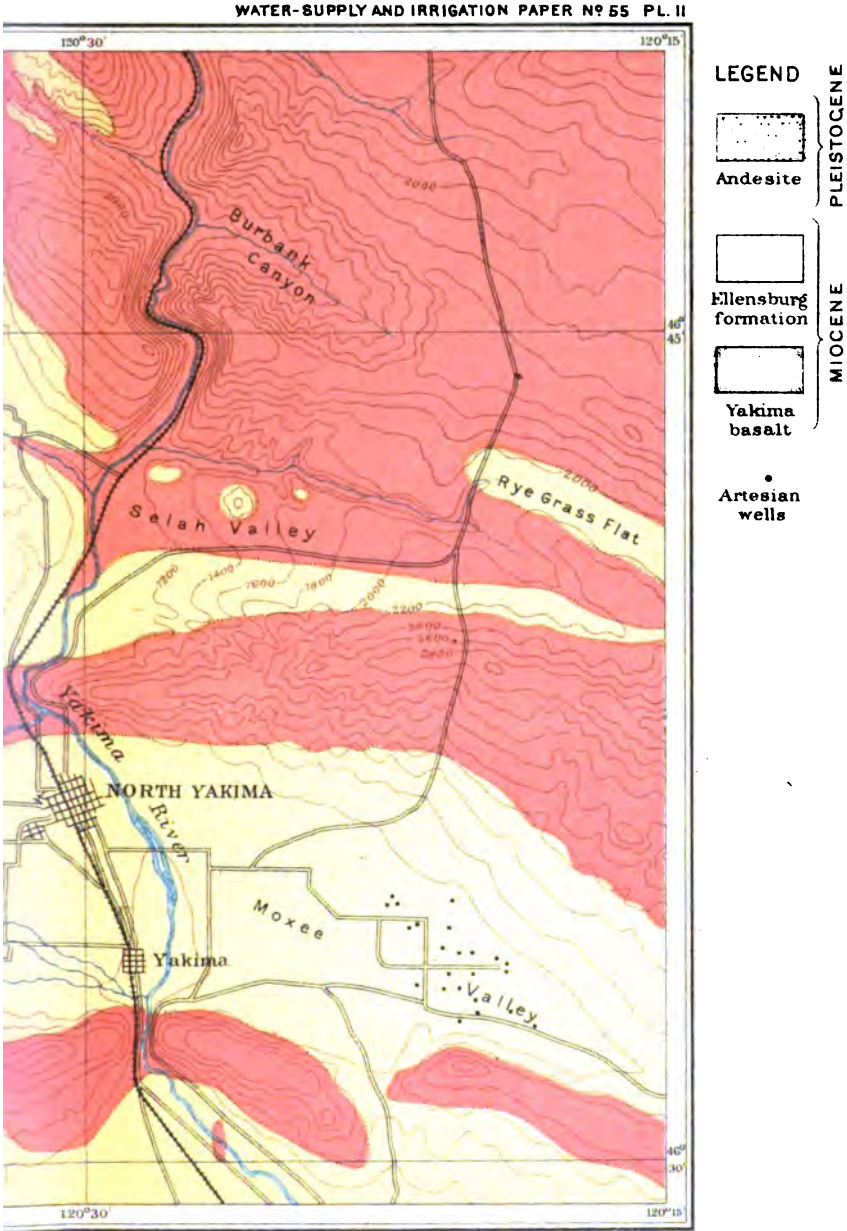

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impossible. It seems probable that with careful selection of northern slopes on ridges where the winter precipitation is considerable and the soil is fine and well fitted to retain the moisture, success may be had in raising these crops. The experience of Mr. John Cleman in raising winter wheat on the north side of Umptanum Ridge is instructive in this connection, for it has proved that that crop can be grown there successfully and profitably.

GEOLOGY.

GENERAL FEATURES.

The basin of Yakima River described here forms an intermediate zone between the Columbia Plains on the east and the Cascade Mountains on the west, and geologically it possesses many features of each. The geologic formations are chiefly those of the Columbia Basin, but the structure is more nearly related to that of the Cascade Range. The rock formations are folded into arches and troughs, but the structure is simple and readily understood by even the railway traveler passing up Yakima River.

The rock seen everywhere along this river is the black basalt, but in certain valleys on the flanks of the ridges white sandstone is visible. These two formations, with the andesite which occurs locally and the alluvium of the valleys, will be described more fully on the following pages.

FORMATIONS.

YAKIMA BASALT.

This formation includes the great series of lavas poured out over this region in late Tertiary time—flood after flood of molten rock, which covered the vast area between what is now the crest of the Cascade Mountains on the west and the mountains of Idaho on the east, and between the mountains of northeastern Washington on the north and the Blue Mountains of Oregon on the south.[1] Solidified tree trunks found at a number of localities show conclusively that considerable intervals separated the lava eruptions. The number of successive flows undoubtedly varies in different parts of the area. In Snake River Canyon, where 3,000 feet of lava is exposed, Russell counted eight distinct lava sheets.[2] Ten or more separate flows can be counted in the canyon of Yakima River, and individual flows be traced great distances. The depth to which the basalt accumulated

[1] The names Columbia lava and Columbia River lava have been used by Prof. I. C. Russell in describing the extensive lava series of the Columbia River Basin. Under these terms are included basalts of both Eocene and Miocene age (Twentieth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 129), also hypersthene-andesite, which is of post-Tertiary age (Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4, p. 43). In the detailed mapping of the Yakima area, which is a part of the Columbia River Basin, it has been found inadvisable to use this general formation name, because the lavas of different ages must necessarily be separated, and therefore the term Yakima basalt is used for that of the Miocene period.

[2] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 4, p. 48.

can be stated only approximately. In the Snake River region the maximum thickness is estimated to be in excess of 5,000 feet.[1] In the Yakima region more than 2,500 feet is exposed in vertical section in the canyon of Yakima River, and as the section includes neither the top nor the base of the lava series, the real thickness may possibly approximate that along Snake River. To the west and north the basalt series is plainly thinner where it overlaps the older rocks.

Examination of the lower contact of the Yakima basalt shows that at the time of the earlier eruptions the topography was extremely rugged. The depressions were, however, gradually filled with molten rock and the inequalities obliterated, just as the waters of a lake conceal the uneven bottom, so that at the cessation of the eruptions the lava series had the aspect of a monotonous waste, rough in detail but generally level over a vast extent of country.

As seen in Yakima County, the basalt is a black rock, compact and heavy. On the weathered surface it is often of a brownish color, but wherever exposed it is dark, and the appearance of the ridges is dull and somber, unrelieved by even the desert vegetation. In a few places, where the residual soil can be found unmixed with alluvial or other foreign matter, it is of a bright-red color.

The most noticeable feature of the basalt rock is the columnar parting by which the black sheets of lava are broken up into long colonnades. In some localities these columns are prismatic, with sharp edges and even sides, the prisms being often so regular as to suggest the work of human hands. This parting is the result of contraction or shrinkage of the solidified lava as the rock mass gradually cooled. The presence of these joint cracks is important, because they afford passages for water in a rock relatively impervious. It therefore is interesting to note the presence or absence of the jointing of the basalt where it is exposed, and such observations have their bearing upon the discussion of the course of the underground waters.

The basalt of certain flows has extremely rough and scoriaceous surfaces, due to small cellular cavities which were formed by the steam in the molten rock and which greatly alter its appearance. These varieties, which tell so graphically the story of the lava eruptions, are less common than the compact basalt. Fine and coarse tuffs, or so-called ash beds, are found at a few horizons in the basalt series, but such beds are insignificant when compared with the thicker and more common lava sheets. In a few instances, however, these fragmental deposits are of importance, one noteworthy locality being Bald Mountain, at the head of Wenas Creek. There the beds of yellow tuff, full of angular fragments of glassy basalt, aggregate

[1] Op. cit., p. 42.

several hundred feet in thickness, and are very noticeable on the northeastern slope of the peak.

ELLENSBURG FORMATION.

Lying directly upon the basalt is the sedimentary series to which the name Ellensburg formation has been given. This series includes partially consolidated sandstones, shales, and conglomerates, with unconsolidated sands and gravels, and represents sediments deposited upon the basalt immediately after the cessation of the eruptions. In the larger part of the North Yakima area, however, some of these sediments were laid down before the eruption of the last flow of the basaltic lava, for at a number of localities 20 to 100 feet of the white Ellensburg can be seen capped by a similar thickness of black lava with the characteristic basaltic parting, over which the succeeding sediments have accumulated to a thickness of more than 1,500 feet. Fossil leaves found in the vicinity of the city of Ellensburg show these deposits to be of Miocene age.[1]

The Ellensburg formation occurs in the valleys, where for the most part, it is concealed under an accumulation of valley alluvium; but it is visible along the banks of the streams and where irrigation ditches have been cut down through the alluvial covering. Along the borders of the valleys the white rocks can be seen, often extending several hundred feet up the lower slopes of the ridges. Such soft rocks as these friable sandstones and shales can not well resist even the slight erosion of this arid country, so that the presence of the Ellensburg formation is frequently indicated only by the bits of andesitic pumice lying on the surface around badger holes.

The best exposure of the series is along the north side of Naches Valley, where the white bluffs extend for miles. Here the character of the rocks can easily be determined. A careful measurement of this section, made by Mr. Frank C. Calkins, who served as geologic field assistant in the survey of the Ellensburg quadrangle, is as follows:

Section of Ellensburg formation along the north side of Naches Valley.

	Feet.
Brown pumice sand, varying in texture and color, in part concealed, approximately	145
Brown pebbly sandstone or conglomerate, with small basalt pebbles in a matrix of ashy sand	100
Gray and brown sandstone and pumice sand	90
Conglomerate, andesitic pebbles, with a few basaltic pebbles, in ashy matrix	15
Brown tuffaceous sandstone, with much pumice	25
Partly consolidated sand, composed mainly of pumice grains	85
Soft light-gray ash	1

[1] Bull. U. S. Geol. Survey No. 108, p. 108.

Section of Ellensburg formation along the north side of Naches Valley—Continued.

	Feet.
Brown pumice sand	10
Porous sinter	1.5
Coarse, brown, tuffaceous sand, partly consolidated	3
Coarse, soft, gray sandstone, composed of angular andesite fragments	2
Yellowish-white pumice conglomerate	5
Fine gray sand, silt, and pumice sand well stratified	2
Coarse to fine-grained, brownish-gray, soft tuffaceous sandstone, with pumice and andesite fragments	25
Pumice conglomerates and interbedded tuffaceous sandstone	12.5
Hard, fine, gray sandstone	1
Fine brown sand, partly consolidated	3
Grayish-brown sand, with a few pumice pebbles	3
Reddish-brown conglomerate, with large bowlders	20
Hard sandstone, with calcareous layers	1
Coarse, gray, pebbly sand, cross bedded	15
Brown tuffaceous sand, with lapilli	1.5
Coarse conglomerate of andesite and pumice	5
Grayish-brown tuffaceous sandstone, with pumice pebbles	6
Well-bedded gray sandstone and shale, with pumice pebbles	18.5
Brown tuffaceous sandstone, pebbly	3
Andesite conglomerate and partly consolidated sand, with some pumice pebbles	30
Pumice and andesite conglomerates	3.5
Fine, cross-bedded, soft sandstone, with bed of angular pumice	9
Coarse pumice conglomerate	1
Fine gray sand and silt, with much pumice	4
Pebbly sand, with pumice pebbles	10
Pale-lavender soft shale	1
Gray tuff and sand	5
Light-brown fine sandstone, grading up into chocolate clay	7
Pebbly sandstone, in part tuffaceous, with intercalated layers of pumice pebbles and fragments	32
Andesitic agglomerate, fine grained	2
Medium-grained gray sandstone	4
Andesitic gravel	4
Coarse sand and gravel	5
Hard sandstone	3
Fine to coarse, medium-fine, gray and brown sands, with lapilli and pumice pebbles	28.5
Coarse sand, with bowlders stained brown	6
Medium-grained hard sandstone	3
Fine andesite gravel, with coarse sand, partly consolidated	10
Gray tuffaceous sand, with fine pumice	6
Conglomerate pebbles, averaging about 2 inches, covered with dark-brown varnish	20
Fine, light-gray, tuffaceous sandstone	2

Section of Ellensburg formation along the north side of Naches Valley—Continued.

	Feet.
Dark-gray coarse sand, cross bedded, with small andesite pebbles	5
Fine to medium-grained, light-gray, tuffaceous sandstone and silt	6.5
Andesitic agglomerate, fine grained	10
Dark-gray sand, cross bedded	1.5
Conglomerate pebbles, mostly andesite, with a few of basalt, averaging about 2 inches, obscurely cross bedded, with lenses of sand	20
Sandy tuff, with fine lapilli	6
Fine gray sand, cross bedded	1
White tuff, fine lapilli in matrix of feldspathic sand	2
Light brownish-gray ash	4
Soft sand	5
Fine white silt	8
Fine, light-gray, tuffaceous sandstone and ash, coarser in upper portion	7
Coarse agglomeratic sandstone, composed of subangular fragments of andesite interstratified with gray sandstones and pumice tuff and conglomerate	38.5
Fine tuff, light gray, structureless	4.5
Rough sandy conglomerate of andesite pebbles	5
Fine, light- to dark-gray, hard sandstone, in part cross bedded, with pumice pebbles	9
Fine light-gray sandstone and brownish tuffaceous sandstone	9
Fine light-gray tuff, with lapilli	2
Fine, light-brown, tuffaceous sandstone, structureless	4
Hard, light-gray, pebbly sandstone and interbedded tuff of fine pumice fragments	11.5
Cross-bedded, soft, gray sandstone, with abundant pumice pebbles	6
Fine andesite agglomerate, grayish brown	1.5
Cross-bedded, fine, gray sandstone and shale, with small pumice pebbles	10.5
White and lavender shale, passing into shaly sandstone above	8
Fine light- to dark-gray sandstone	10
Cross-bedded dark-gray sandstone, with pumice pebbles	3
White shale	1.2
Fine to coarse, gray, tuffaceous sandstone, structureless, with some pumice pebbles	14
White shale and fine gray sandstone, interbedded	19
Lavender and white laminated shale, in part sandy	10
Light rusty-brown agglomeratic sandstone	8
Cross-bedded sand and gravels, pebbles with blackened surfaces	8
Fine-grained gray sandstone and silt	15
Medium-grained tuff composed of lapilli	1
Light-gray sandstone grading into silt	15
Conglomerate, with large and small andesite pebbles and sand lenses	60

Section of Ellensburg formation along the north side of Naches Valley—Continued.

	Feet.
Fine, soft, gray sandstone and silt, coarser in upper portion, cross bedded	8.8
Medium-fine light-brown tuffaceous sandstone	9
Gray and greenish soft sandstone and sandy shale	10
Medium to coarse light-gray sandstone, locally grading into fine conglomerate	20
Fine, soft, light-gray sandstone and lavender shale	1.4
Coarse brown silt	4
Conglomerate, finer in lower portion	6
Coarser cross-bedded sandstone, with pebbles	6
Fine conglomerate and medium-grained light-gray sandstone	2.7
Coarse to fine, gray, cross-bedded sand	5
Lavender silt and ash, with lapilli, white above	7
Fine lapilli, unconsolidated	1
Fine light-brown sandstone	4
Coarse tuff, with rounded pumice pebbles in a sandy matrix	3
Light-gray tuffaceous sandstone, with lapilli	2
Fine andesitic agglomerate	3
Medium-grained, gray and yellow, soft, cross-bedded sandstone, with small pebbles	8
Medium to fine tuffaceous sandstone, buff colored, structureless	8
Medium to coarse-grained, cross-bedded, bluish-gray sandstone, with small pumice pebbles	12
White silt	1
Light-gray cross-bedded sandstone and silt	10
Drab and gray tuffaceous sandstone, structureless	15
Soft white tuff of fine pumice fragments	1.5
Soft tuffaceous sandstone, structureless	7
Cross-bedded gray sand, with pumice pebbles and interbedded silt	6
Fine drab sand and lavender silt, interbedded	6
Fine lavender tuff, structureless	1.3
Fine sand and clay, irregular stratification	5
Medium-grained sand, with scattering pebbles of pumice	1.5
Fine light-gray sand and lavender-colored silt	3
Dark-gray cross-bedded sandstone, with small pumice pebbles	6
Hard, grayish to brownish, medium-grained sandstone	2.5
Coarse gray sandstone and tuff, with lapilli in sandy matrix	1.5
Fine sand and lapilli, partly consolidated	1.5
Tuff, with angular fragments of andesite, pumice, and feldspar	4
Fine light-gray sandstone, with beds of silt in upper part	16
Lavender shale	1
Light-yellow ash and lavender shale, passing into fine sandstone	10
Conglomerate, with seams of sand, large andesite and pumice pebbles	10

Section of Ellensburg formation along the north side of Naches Valley—Continued.

	Feet.
Medium to coarse, cross-bedded, soft, gray sandstone, finer in upper portion	10
Lavender-colored ash, feldspathic	5
Medium-grained, light-brown to greenish, tuffaceous sandstone, with andesite and pumice pebbles	4
Cross-bedded sand, with lapilli and andesite pebbles	9
White tuff, with small angular lapilli	.5
Interbedded silt and sand, drab colored, with lapilli	7
Fine, bluish-gray, soft sandstone, with pockets of lapilli	8
Medium coarse gray sandstone	3
Lavender tuff, with a medial bed of drab-colored silt	2
Coarse sandstone, with much feldspar and fine lapilli, finer toward the top	3.5
Coarse light-gray ash	2
Medium-grained, light-gray, tuffaceous sandstone, with angular lapilli	1.8
Medium- to fine-grained gray sandstone	9
Coarse, stream-bedded, gray sandstone, with pebbles of andesite and pumice	2.8
Conglomerate, with small pebbles of andesite and larger pebbles of pumice; some sand lenses	4.5
Coarse buff-colored ash containing much feldspar	7
Gray sandstone and silt	20
Fine light-gray ash, structureless	20
Sand and gravel, stream bedded, pebbles 2 inches average diameter, gravel finer in upper portion	33
Fine gray ash, structureless, silky luster, composed of fine particles of glass	4
Fine, gray, tuffaceous sandstone, with lapilli one-fourth inch in diameter	3
Conglomerate interbedded with sand; pebbles of black andesite 1 to 4 inches in diameter	10
Basalt, two flows, columnar, with vesicular upper surfaces, 25 feet in thickness	------
Gray ash	1
Light-gray tuff, with pebbles of andesite	25
Total sediments resting upon upper surface of main body of Yakima basalt	1,569.5

As will be seen from the foregoing section, the most noteworthy characteristic of the Ellensburg formation is the presence throughout of white andesitic pumice in angular pebbles and small bowlders. More compact andesitic lava is the material next in importance, while basalt is noticeably unimportant. The rare and sporadic occurrence of pebbles of basalt in this sedimentary formation is remarkable, and, as shown in the section, the basaltic material is more common near the top of the series. Another conspicuous feature is the cross bedding of the sandstones. These characters afford evidence as to the nature of the water body existing at that time and the conditions of sedimentation.

It is demonstrated that in Miocene time, immediately following the eruptions of the great basalt flows, central Washington was covered with water, but until the whole area has been studied it can not be stated how extensive or how deep this body of water was. In the North Yakima region the streams washed down vast quantities of material from adjoining areas where andesitic lava was being erupted. Stream-rounded pebbles and bowlders were thus deposited; and the deposition apparently took place in shallow water, since the stratified beds of sand and gravel show the effect of currents which could not have existed in deep waters. The beds of finer material, however, are more perfectly stratified, showing that at times deposition took place in more quiet waters.

ANDESITE.

Between the lower Naches Valley and the valley of Cowiche Creek there is a broad plateau with peculiar features. Its topography is noticeable from the presence of undrained depressions and a general hummocky surface. It is about 12 miles long, from 1½ to 3 miles wide, and from 300 to 700 feet above the valley. It represents the lower end of a lava stream which had its source in the Tieton Basin, to the west, and following down the canyon of Tieton River flowed out over the broad valley at the junction of Cowiche Creek and Naches River. The irregular though generally flat surface remains just as when the molten rock cooled, while at the edges of the old flow the columnar jointing of the cooled lava is seen. The latter feature is exhibited in a wonderful manner at Pictured Rocks. (See Pl. IV.) The rock of this plateau is an andesite which occurs nowhere else in the area here discussed. Its eruption occurred much later than the great basalt eruptions, and in fact is the latest important incident in the geologic history of the region. As this andesite area has little or no agricultural value, being too high to be supplied with water, its eruption may be regarded as of the nature of a disaster. The flood of molten rock poured into Naches Valley and doubtless converted fertile bottom land into this arid plateau.

ALLUVIUM.

The valleys of this region owe their value for agricultural purposes to the fine-grained alluvial deposits. The finest of silt extends over large areas of bottom lands, which represent the sediments that have been deposited by the streams flowing slowly upon their flood plains. In the Atanum-Moxee Valley some fine material doubtless was deposited in the ponded waters during Glacial times, when a large lake covered hundreds of square miles in central Washington, and when the large granite bowlders that are found in Wide Hollow were dropped from masses of ice floating in this lake, to which the name Lake Lewis has been given. Farther south these fine lacustrine deposits are more prominent, and can be seen at many points along

the roads south of Union Gap. In fact it is this fine silt deposit which renders these roads almost impassable during the dry season. Under irrigation, however, this land becomes of great agricultural importance. Coarser alluvium, sand, and gravel cover portions of the valleys. In no place, however, are these areas of coarse material large. Such gravel flats can be seen near the junction of Naches and Yakima rivers, where they form low terraces, but even these gravel-covered areas are not without agricultural possibilities, as is proved by the orchards in the vicinity.

STRUCTURE.

The geologic structure of the North Yakima region is simple. The manner in which the rock formations are built up to form the crust of the earth, or what might be termed its architecture, is often exceedingly complicated, and in most localities the constant tearing down by atmospheric agencies most effectually conceals the plan of construction. In this region, however, owing to the arid climate, the action of running water has affected the surface very little, except where certain larger streams have cut their canyons. So it is that the configuration of the surface very clearly indicates the structure of the rocks beneath. This direct relation between topography and structure is exceptional, but its presence in the vicinity of North Yakima renders it possible to see and understand the manner in which the rocks have been folded, and consideration of the structural relations is quite essential to the discussion of the problems connected with the artesian water supply. The parallelism between the surface and the rock structure is shown in the fact that the ridges are rock arches and the valleys inverted arches or troughs. In more technical language, the ridges are anticlines and the valleys are synclines.

ARCHES.

The anticlinal structure can be observed at many places where Yakima River has cut across the ridges, as, for instance, at Union Gap, a few miles south of North Yakima, where on either side of the river the sheets of basaltic lava can be traced upward from the river level in a broad arch extending high up on the steep sides of the gap, and then down again to the river. (See Pl. V, *A*.) A similar arch is shown in the gap north of North Yakima, but there the relations are not so distinct, because the Yakima and Naches rivers in their meanders have cut away portions of the sides of the arch. Farther east, however, along Selah Ridge, the arch can be seen in its entirety. To the north, the next ridge which lies between Selah Creek and Burbank Canyon shows very plainly this same arched structure, and at many other places along Yakima River opportunity is afforded for observing, even from the car window, the geologic structure of the region.

Atanum or Yakima Ridge is one of the more prominent of the anticlinal ridges of the district, and from its proximity to the artesian-

water area it deserves a few words of description. As a ridge it begins in the elevated region south of the headwaters of the South Fork of Atanum Creek; thence it extends eastward about 25 miles, to Union Gap, being well-defined, from 2 to 3 miles broad, and rising from 1,000 to 1,500 feet above the bordering valleys. Its slopes are gentle and its crest is even, with a slight eastward slope. At Union Gap, where, as already mentioned, the anticlinal structure of the ridge is plainly revealed, it is interrupted by a canyon 1 mile in length, 800 feet in depth, and as steep sided as a railroad cut. Five miles east of Union Gap there is a sudden change in the structure and in the topography of the ridge. The crest of the arch shows a distinct saddle or transverse buckle, so that a low pass is formed not more than 100 feet above Moxee Valley, to the north. Here the basalt, which is prominent on the ridge throughout its whole extent westward, drops below the surface, and the Ellensburg sandstone overlying the basalt is found in the pass where the wagon road crosses. East of this pass the arch of basalt reappears, and the ridge for the most part assumes its topographic character and extends for many miles to the southeast, where, according to Professor Russell, it finds its continuation in Rattlesnake Mountain.

Selah Ridge, north of North Yakima, is of the same type of structure as Atanum Ridge. It begins on the north side of the headwaters of Atanum Creek, forming Cowiche Mountain, a well-defined anticlinal elevation with a general east-west trend. East of Cowiche Mountain the ridge is somewhat lower, and is also cut by Cowiche Creek and Naches River. In this portion it appears to have lost much of its anticlinal character, through the undercutting of its flanks by the meanders of Yakima River, as already mentioned. East of Yakima River the full arch can be seen, and the ridge continues eastward many miles, in fact not dying out until Columbia River is reached.

Other ridges occur to the north and south of those just described, and, like them, have a general east-west trend and are, without exception, anticlinal in structure. The arches have flat crests and steep sides, so that where best exhibited the cross section is comparable to an inverted U. The steep sides of the anticline cause steep slopes of certain of these ridges, and the change from the gentle slope near the crest to the steeper slope on the side of the arch is often so sudden that a fault scarp is suggested. A careful study of these ridges in the excellent sections afforded by the gaps cut by Yakima River fails to show the presence of any extensive or important fault, and the general absence of faulting may in fact be mentioned as one of the characteristics of the region.

TROUGHS.

As already noted, in the description of the topography of the region, a conspicuous feature is the presence of long valleys, which in their

medial portions are crossed by Yakima River. The correspondence between topography and structure is expressed in the noticeable fact that wherever one of these east-west valleys is seen on one side of Yakima River its continuation is to be found on the opposite side. The Atanum-Moxee Valley is such a depression, and is the most important in the present discussion, for it is there that the artesian wells are located. This valley is 40 miles long, about 6 miles wide, and has a general east-west trend, being crossed by Yakima River about midway in its length. The slope from Yakima River to either end of the valley is very gentle, and to the east Moxee Valley finds its continuation in Rattlesnake Valley, just as Atanum Ridge to the south finds its eastward continuation in Rattlesnake Mountain. The elevation of the floor of this valley in the vicinity of North Yakima is between 1,000 and 1,100 feet above sea level. The structure of the trough is best indicated by the fact that the upper beds of basalt, which occur on the surface along the crest of Atanum Ridge to the south of the Atanum-Moxee Valley at an elevation of about 2,150 feet, are found at a depth of about 1,200 feet below the surface of the valley.

The Wenas-Selah syncline is to the north of Selah Ridge. While Wenas Valley is not so plainly a valley of the same type as that already mentioned, it has an eastward continuation in Selah Valley which is exactly similar to Moxee Valley, to the south, except that the basalt is not so deep beneath the surface as in the latter valley. The valley of Roza Creek and Burbank Canyon constitutes the next synclinal valley to the north, being followed by the Umptanum-Squaw Creek Valley. In these cases the trough is well shown on both sides of Yakima River. Farther north is Kittitas Valley, a valley of the same type, in which is situated the city of Ellensburg, and which is the next area of agricultural importance to the north of North Yakima. South of North Yakima the Reservation Valley has a similar structure and the same topographic characters.

Such of these valleys as are important in the discussion of the artesian problems will be described more fully further on.

WATER RESOURCES.

In an arid region like the North Yakima country, where extensive areas are well adapted to agricultural purposes, by reason of the favoring topography, the composition and texture of the soil, and the moderately high mean annual temperature, water becomes one of the most valuable natural resources. Upon it depend land values, so that the proper conservation and utilization of the water supply is of greatest economic importance. Such a water supply is in part visible and in part concealed. The former comprises the rivers and streams, and will be discussed under the title of surface waters. The latter includes the water stored beneath the surface, or the underground water. Both have one origin, being derived from the rainfall and

snowfall, the surface waters representing the run-off and the underground waters that portion which sinks beneath the surface. In an arid region neither the surface waters nor the underground waters are wholly indigenous, but are derived from adjoining areas where the precipitation is heavier, so that, in order to discuss intelligently this economic problem, observation must cover a great expanse of country.

SURFACE WATERS.

Although the area herein described lies within the Arid Region, it is close to the western border of that belt, and is, therefore, well supplied with flowing streams, which have their source in the mountains. These will be described briefly, on account of the important bearing which they have upon the subject of irrigation in these valleys.

YAKIMA RIVER.

The master stream of the area is Yakima River. East of this river the tributary streams are only seasonal, but those entering from the west are more important. These tributaries, like the Yakima, head against the snow peaks of the Cascade Range. Yakima River has its source in Keechelus Lake, close to the crest of the range. This lake is supplied with water from the surrounding peaks, on which the snow remains until late summer, and in many cases persists from year to year. Kachess and Clealum rivers are the two important headwater tributaries of the Yakima, being the outlets of large lakes of the same names. Both of these rivers are supplied throughout the summer by melting snow and glacier ice. The next large tributary is Teanaway River, which drains an extensive area to the north of Yakima Valley. Other tributaries are Swauk, Reeser, Taneum, Manastash, Wilson, and Naneum creeks, the waters of all of which are used in the irrigation of Kittitas Valley, the important broad valley in which Ellensburg is situated. In 1892 extensive plans were proposed by the Northern Pacific land department for irrigating Yakima Valley, and detailed surveys for reservoir sites were made on the three lakes mentioned. All of these lakes outlet through glacial deposits, and it was proposed by the Northern Pacific, Yakima and Kittitas Irrigation Company to construct crib dams 30 feet in height at the lake outlets. This plan, however, was not carried out, although timber for the purpose was prepared and remains piled up at the outlet of Keechelus Lake.

Several years ago a canal was proposed to take water from Yakima River at Easton, and portions of it were constructed. It is known as the Kittitas Valley irrigation canal, and if completed it would have irrigated a large portion of that valley. At present the valley, which comprises a large amount of arable land well adapted to the cultivation of alfalfa and the cereals, is irrigated solely by local ditches, which use the water from the creeks already mentioned.

One of these, Reeser Creek, receives some water which has been diverted into its channel from First Creek, one of the tributaries of Swauk Creek. This diversion is interesting, as the water is made to follow the old abandoned waterway through Green Canyon. Some attempt has also been made to improve the water supply of Manastash Creek, a small dam having been built at the outlet of Manastash Lake, so that a small amount of water is stored at that point.

Tributary streams which enter Yakima River within the area here discussed are Wenas Creek, Naches River, and Cowiche and Atanum creeks.

WENAS CREEK.

Wenas Creek drains the limited area lying south of the Manastash drainage and east of the small tributaries of Naches River. As seen on the map (fig. 1), it has a general southeasterly course and enters

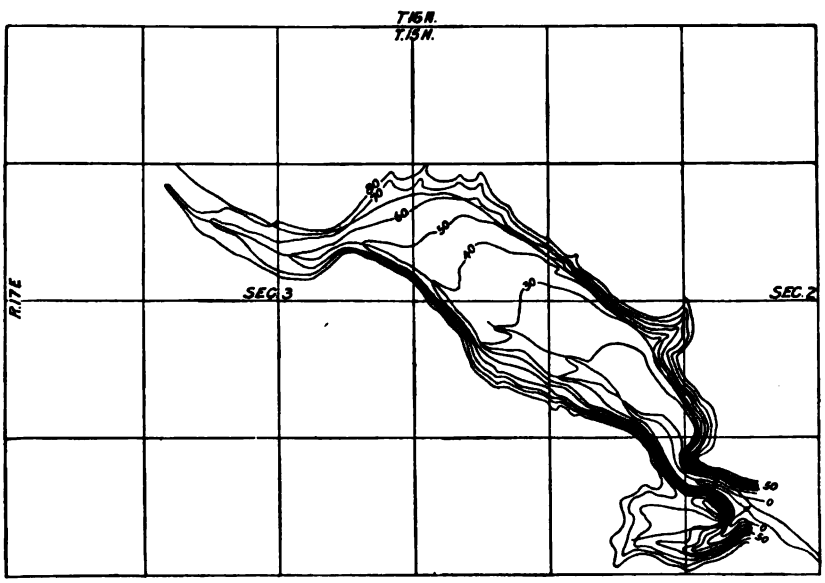

FIG. 2.—Map of reservoir site on Sherman's ranch, Wenas Creek.

Yakima River about 10 miles above the city of North Yakima. It drains a broad, fertile valley, which was early settled, being on the old stage road between The Dalles and Ellensburg, and the region beyond. Irrigation along the stream has, therefore, been developed to a considerable extent, and the ditches built effected so complete a diversion of the water during the dry seasons that lawsuits have been brought to determine a proper division of the water. The courts have ordered a more or less equitable division, but this solution of the problem is not wholly satisfactory, and attempts have been made to devise a system of storage.

The natural basin in secs. 2 and 3, T. 15 N., R. 17 E., was examined

by Mr. Cyrus C. Babb in 1898. The results of the survey made at that time are given in the following table:

Capacity of reservoir site on A. L. Sherman's ranch, Wenas Creek.

Contour.	Area.	Capacity.	Total capacity.
Feet.	*Acres.*	*Acre-feet.*	*Acre-feet.*
0	0.1	1	1
10	3.9	20	21
20	16.0	100	121
30	38.3	271	392
40	56.1	472	864
50	74.2	653	1,517
60	88.4	812	2,329
70	106.0	972	3,301
80	123.6	1,149	4,450

A similar investigation was made by Mr. Sydney Arnold in the summer of 1900, when what is known as the O'Neil reservoir site was

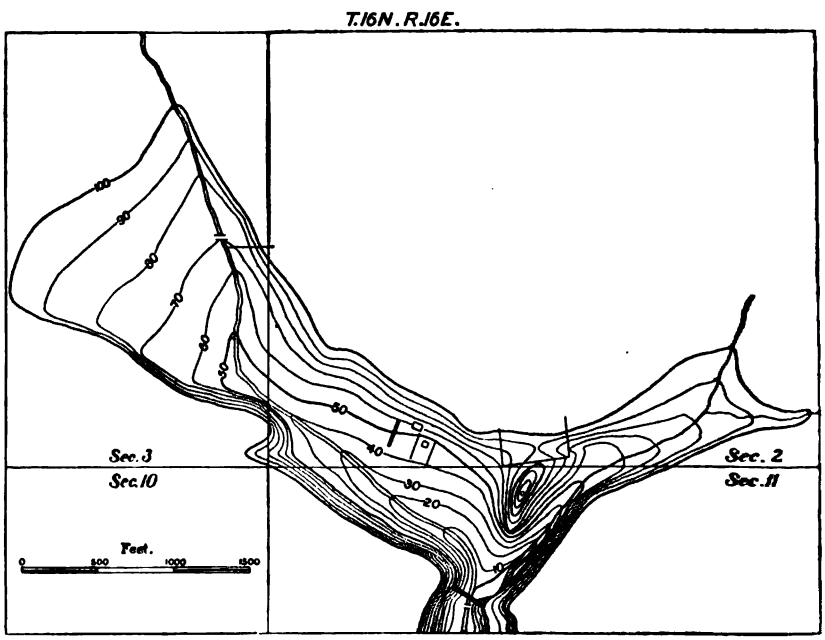

FIG. 3.—Map of O'Neil reservoir site on Wenas Creek.

surveyed. The resulting map is reproduced here (fig. 3) in 10-foot contours. The length of the dam at the base would be 90 feet; the top length at an elevation of 80 feet would be 350 feet. The total capacity of the reservoir with a dam of that height would be 1,753 acre-feet, and the capacity with a dam 100 feet high would be 3,519 acre-feet. Results of the survey are disappointing, in that the total content of the reservoir is small compared with the size of the dam required. A view of the dam site is shown in Pl. III, *A*. The fol-

A. DAM SITE OF PROPOSED O'NEIL RESERVOIR.

B. IRRIGATED LANDS ON SOUTH SIDE OF MOXEE VALLEY.

lowing table gives the capacity of a reservoir at this site for every 10-foot contour:

Capacity of O'Neil reservoir site on Wenas Creek.

Contour.	Area.	Capacity.	Total capacity.
Feet.	*Acres.*	*Acre-feet.*	*Acre-feet.*
0	0	0	0
10	1.8	1	1
20	4.9	34	35
30	9.0	70	105
40	15.2	121	226
50	25.0	201	427
60	36.4	307	734
70	50.1	432	1,166
80	67.3	587	1,753
90	87.6	774	2,527
100	110.8	992	3,519

An attempt has also been made by some of the ranchers in Wenas Valley to divert waters tributary to Naches River around the southern slope of Bald Mountain into the North Fork of Wenas Creek. When seen in the summer of 1900 the ditch dug for this purpose did not appear to be a success.

NACHES RIVER.

Naches River is considered the most important stream for irrigation purposes in the State of Washington. It reaches Yakima Valley at a point where its waters are immediately available for irrigating extensive areas of the best agricultural lands. Already a number of irrigation systems take water from this river, and in view of new irrigation projects its storage possibilities have been investigated by the hydrographic division of the Geological Survey.

In the summer of 1897 Mr. Cyrus C. Babb made a survey of a reservoir site at Bumping Lake, on Bumping River. This lake, which is within the Mount Rainier Forest Reserve, lies close to the crest of the Cascade Range and is surrounded by high peaks. Its shores are covered with dense forests. On August 26, 1897, a measurement of the discharge at the outlet was made, giving 83 second-feet. At that time the water surface was 115 feet wide. The water marks around the lake show an annual fluctuation of about 3 feet. Its height may reach 7 feet during exceptionally wet seasons or after a winter of heavy snowfalls. At a height of 10 feet the water surface would be about 150 feet wide. The length of the proposed dam, at a height of 25 feet above the bed of the river, would be 480 feet. The area of the lake is 631 acres; the area at the 25-foot contour, the height of the proposed dam, is 1,153 acres, giving a reservoir capacity of 22,300 acre-feet. The Northern Pacific, Yakima and Kittitas Irrigation Company surveyed this site in September, 1894, and prepared for construction by hewing, in the immediate vicinity, tamarack timbers for the dam. These are now piled up at the outlet of the lake.

Tieton River, which enters the Naches about 15 miles above its mouth, is an important stream, and being in greater part fed by

glacial streams it maintains a large discharge during the hot months of summer, when its waters are most needed for irrigation purposes.

The North Yakima region is the most extensively irrigated of any district in the State of Washington, and the importance of Naches River is shown by the canals which take water from it. Some of the principal of these may here be mentioned.

The Selah Valley irrigation canal is on the north side of Naches River, its intake being just above the mouth of Tieton River. It is about 30 miles in length, and irrigates about 3,000 acres, under cultivation, in Naches and Selah valleys. Below this, on the north side, head the Wapatuck and Naches canals, 17 and 7 miles long, respectively, which irrigate the bottom lands of Naches Valley.

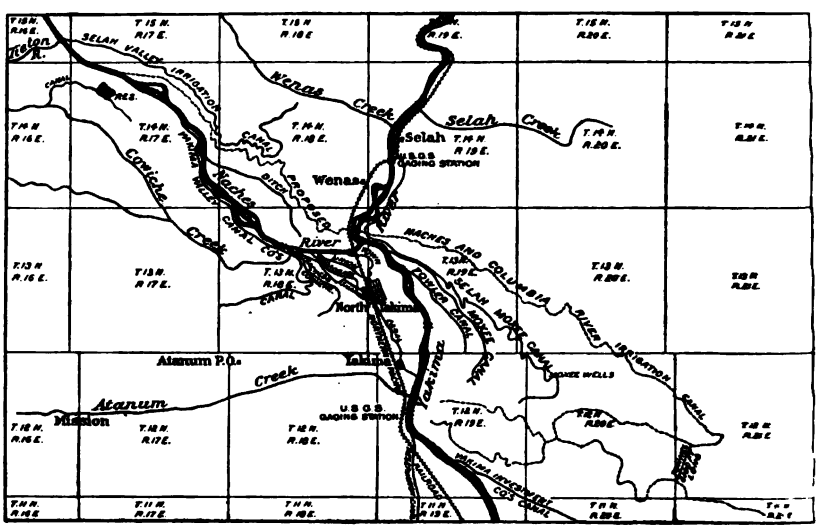

FIG. 4.—Map of vicinity of North Yakima, showing irrigation canals.

On the south side the Yakima Valley canal heads about 12 miles from North Yakima. (See Pl. IV.) For the first 10 miles of its course it is in a flume. At the high point known as Pictured Rocks it is carried around on a trestle about 70 feet high, and then crosses Cowiche Canyon in an inverted siphon; thence it continues in flume and canal around into Wide Hollow, but it has not been found expedient to extend it farther into Atanum Valley, for the reason that the canal is not high enough to cover much of the valley, and because it carries hardly sufficient water for the land now under it, for which water rights have been sold. The length of the canal is 16 miles, and it irrigates 3,000 acres.

The Hubbard ditch heads close to Pictured Rocks, on the south side of Naches River, just below the bridge crossing that stream (Pl. V, *B*). This ditch, with the Yakima Water, Light and Power Company's canal, and the Shanno, Broadgage, Union, and Town ditches, which head between the Hubbard ditch and the lower highway bridge, in the order named, serves to water the lands in the immediate vicinity

SIPHON OF YAKIMA VALLEY CANAL, COWICHE CANYON.

of the city of North Yakima. The Yakima Water, Light and Power Company's canal discharges into the reservoir, whence a drop of 20 feet is obtained, developing sufficient power for the city pumping plant and the electric lights.

In 1895 the survey for a large canal, called the Naches and Columbia River irrigation canal, was made under the direction of the State arid land commission, formed after the passage of the Carey act. The intake of this canal was to be on the north side of Naches River, 3 miles below the head of the Selah Valley canal. The canal was to cross Yakima River a short distance above the mouth of Naches River, by means of an immense inverted siphon, circle Moxee Valley, pass through the ridge east of Union Gap, by a tunnel 6,100 feet long, and continue down Yakima Valley to Rattlesnake Mountain, around which it was to pass to lands overlooking Columbia River. It was to be 140 miles long, and to carry at its head 2,000 second-feet of water. The intention was to use the Bumping Lake storage reservoir. No work has been done on this canal.

A few years ago a survey was also made for a canal called the Burlingame canal, which was to take water from the south side of Naches River, just below the mouth of Tieton River, and carry it around into Atanum Valley, thence around Atanum Ridge, to the bench lands above Toppenish Creek on the Yakima Indian Reservation. About 3 miles of construction work was done on this canal near its head. The canal as far down as Pictured Rocks would be expensive to construct, on account of the andesitic formation through which it would pass, and doubtless would be very expensive to maintain.

Mention may here be made of four canals which take water from Yakima River nearly opposite the mouth of Naches River and constitute the irrigation supply for the lower part of Moxee Valley, just southeast of the city of North Yakima. These are the Selah-Moxee canal, recently constructed,[1] the Moxee Company's canal, the Hubbard ditch, and the Fowler ditch. The last three irrigate about 3,000 acres; the Selah-Moxee irrigates about 5,000 acres.

The largest canal of the region is Sunnyside canal, which has its intake on the east side of Yakima River, about 9 miles south of North Yakima and close to the southern edge of the area included in the map (fig. 4). It is 42 miles long, and was constructed by the Yakima Investment Company, successors to the Northern Pacific, Yakima and Kittitas Irrigation Company.

COWICHE CREEK.

Cowiche Creek, which flows into Naches River about 3 miles from North Yakima, is formed by two forks which in the vicinity of their junction have rather extensive alluvial bench lands. The headwaters of these forks do not reach back far enough to secure a constant supply of water, and on this account attempts have been made to

[1] This canal was opened about June 1, 1901.

devise a storage system. The plan adopted was the construction of a reservoir on the plateau between Cowiche Creek and Naches River. A natural depression in the surface of the hard andesitic lava flow was utilized, and retaining dams were constructed, making a reservoir which can be filled during the flood season in the early spring, at which time an abundant supply of water is furnished by the North Fork of Cowiche Creek. This reservoir does not hold sufficient water to irrigate more than a very small portion of the Cowiche bottom lands, but it is of interest as it is the first of its kind in the State.

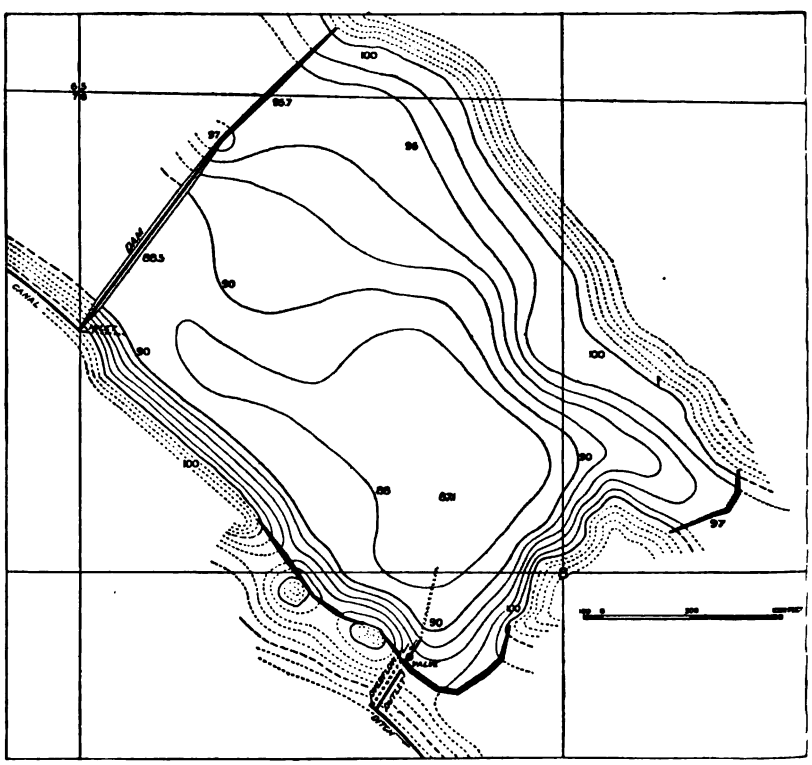

FIG. 5.—Map of Cowiche reservoir.

ATANUM CREEK.

Atanum Valley, which includes the southwestern portion of the North Yakima area, was one of the earliest sections settled in this vicinity. Here, again, nearly all of the available summer flow of the creek has been utilized for irrigation, and as a consequence a number of cases have been tried in the courts. During the season of unusually low water in 1892 an action was brought in the superior court of Yakima County, by certain riparian proprietors on Atanum Creek, "to restrain certain appropriators from diverting the water of said stream from above and conducting the same to and from their land, situated at a distance therefrom, for the purpose of irrigation." The

injunction was granted, and the case was appealed to the State supreme court, where it was upheld, by decision rendered July 2, 1897. A large tract of land is under cultivation on the benches north of the river, and it would seem that under this decision irrigation will have to be discontinued unless water can be obtained from other sources.

On July 26, 1897, the discharge of Atanum Creek just below the junction of the North and South forks was 40.1 second-feet. This is above the head of most of the important canals. In July, 1897, a series of measurements of Atanum Creek and the canals taking water therefrom was made by Mr. Cyrus C. Babb, for the purpose of determining the seepage, or the amount of water returning to the creek. The following table, prepared by Mr. Babb, gives the results of these measurements:

Discharge measurements made in July, 1897, of Atanum Creek and canals taking water therefrom.

	Second-feet.
North Fork of Atanum Creek above Anderson's ranch, sec. 12, T. 12 N., R. 15 E	50.1
Cox ditch at Charles Anderson's, sec. 12	6.9
Two small ditches below Cox ditch, sec. 12	1.0
Slough at Dan Kinney's house, sec. 7, T. 12 N., R. 16 E	4.5
North Fork road bridge near Tampico, sec. 18	25.2
Waste water near Allen's house (into creek)	2.2
Atanum Creek below forks, sec. 17	40.1
Dan Lesh ditch, sec. 16	.6
Atanum Creek at Narrows, or Rocky Cliff	49.8
Herke's ditch (upper), sec. 14	.5
Herke's ditch (lower), sec. 14	.5
Morris ditch above North slough	2.5
Small Catholic Mission ditch	.3
North slough above mission, sec. 13	23.4
Atanum Creek 100 feet below Middle slough	9.0
Middle or Second slough 75 feet below head, sec. 18, T. 12 N., R. 17 E	9.8
Lynch ditch, sec. 17	.3
Yallup Indian ditch, sec. 16	8.4
Atanum Creek below Indian ditch	8.4
Simpson's ranch ditch	3.0
Woodhouse ditch	.6
Atanum Creek at Woodhouse ranch, sec. 14	.7
Atanum Creek at Tanner bridge, sec. 8, T. 12 N., R. 18 E	.8
Indian ditch, sec. 8	1.0
Atanum Creek at line between secs. 11 and 12	.9
Waste slough, sec. 1	2.5
Wide Hollow waste slough, sec. 1	14.9
Atanum Creek at Union Gap bridge, sec. 8, T. 12 N., R. 19 E	12.5

In September, 1898, a reconnaissance was made by Mr. Babb, for the purpose of thoroughly exploring the upper basin of Atanum Creek to ascertain whether there existed any possible reservoir sites in which, by the construction of suitable dams, the spring freshets of the stream could be stored and used upon the irrigable lands below

during times of low water. The results of this investigation were disappointing, no reservoir sites being found.

In order to determine whether an additional water supply for Atanum Valley could not be obtained by the diversion of some of the tributaries of Klickitat River across the divide into Atanum Basin, in August, 1900, Mr. Sydney Arnold made a reconnaissance of the Klickitat Basin. Diamond Fork of Klickitat River and South Fork of Tieton River receive their waters from the peaks of Goatrock Mountains, which are covered with snow throughout the year, thus insuring a constant supply. Gold Fork of Klickitat River, the only stream to be considered in this connection, drains a lower country and has not so abundant a supply. Mr. Arnold's investigation showed the futility of any diversion from the Klickitat Basin into the Atanum Basin. Gold Fork is lower, by at least 1,000 feet, than the lowest elevation of the divide between it and the basin of Atanum Creek. The lowest point of the divide between the Tieton and Gold Fork, as shown by leveling, is lower, by several hundred feet, than any point on the Atanum-Klickitat divide, so that none of the waters of Gold Fork can be carried over to Atanum Creek.

GAGING STATIONS AND RECORDS.

A number of gaging stations have been maintained by the United States Geological Survey on Yakima River and its main tributary, Naches River. On August 14, 1893, a station was established on the latter stream at the highway bridge a short distance above its mouth. (See Pl. V, *B*.) Owing to the change in the channel, by excessive floods, the station was discontinued in 1897, but was resumed the following year, from which time continuous records have been maintained.

A gaging station on Yakima River was established at Union Gap, 7 miles below North Yakima, on August 14, 1893, but continuous records have been maintained only since August, 1896. (See Pl. V, *A*.)

In 1897 an attempt was made to obtain data regarding the flow of Naches River, and accordingly a gaging station was established on Yakima River at the Selah bridge, 4 miles above the mouth of Naches River, the idea being that the difference between the discharge at the station at Union Gap, below Naches River, and that at Selah, above the river, would give the discharge of that stream. The results were not altogether satisfactory, however, for the canals of Moxee Valley divert water between the two stations, and some waste water from the Naches River canals enters between the two points. It was for this reason that the Naches station was resumed in 1898.

The following tables give the monthly discharges at the three stations mentioned for the periods during which continuous records have been kept.

More detailed descriptions of these stations will be found in the various annual reports of the Geological Survey, Part IV, and in Water-Supply Papers Nos. 16, 28, and 38.

A. GEOLOGICAL SURVEY GAGING STATION ON YAKIMA RIVER AT UNION GAP, WASHINGTON.

B. NACHES RIVER NEAR GAGING STATION, SHOWING WING DAM AND HEAD GATES OF NACHES AND COWICHE CANAL COMPANY.

Estimated monthly discharge of Yakima River at Selah, Wash.

[Drainage area, 1,960 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1897.						
May 19-31	13,848	6,142	9,318	240,266	4.75	1.97
June	6,391	2,875	4,021	239,266	2.05	2.29
July	3,745	1,012	2,057	126,481	1.05	1.21
August 1-21	1,015	644	811	33,798	.41	.33
September	.....	.....	a 700	41,653	.36	.40
October 20-31	828	828	828	19,704	.42	.17
November	19,811	828	3,979	236,766	2.03	2.26
December	8,570	1,472	2,702	166,140	1.38	1.59

Estimated monthly discharge of Naches River at North Yakima, Wash.

[Drainage area, 1,000 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1896.						
August	1,640	490	849	52,203	0.85	0.98
September	490	350	417	24,814	.42	.47
October	450	310	347	21,336	.35	.40
November	5,200	365	1,707	104,945	1.71	1.91
December	2,950	1,450	1,940	117,071	1.94	2.24
1898.						
January	.....	.....	a 500	a 30,744	a .50	a .58
February	.....	.....	a 3,000	a 166,612	a 3.00	a 3.12
March	2,131	913	1,507	92,662	1.51	1.74
April	5,800	1,019	3,159	187,973	3.16	3.53
May	7,480	4,120	5,186	318,877	5.19	5.98
June	6,640	2,484	4,500	267,768	4.50	5.02
July	2,867	1,019	1,798	110,555	1.80	2.08
August	1,019	385	594	36,524	.59	.68
September	607	325	362	21,540	.36	.40
October	811	325	445	27,362	.45	.52
November	709	385	510	30,347	.51	.57
December	2,867	225	580	35,663	.58	.67
The year	7,480	225	1,845	1,326,627	1.85	24.89
1899.						
January	4,325	600	1,458	89,649	1.46	1.68
February	2,675	1,350	1,827	101,466	1.83	1.91
March	1,500	950	1,115	68,559	1.12	1.29
April	3,950	1,200	2,246	133,646	2.25	2.51
May	6,700	2,500	4,534	278,785	4.53	5.22
June	6,700	5,500	6,220	370,116	6.22	6.94
July	5,800	2,850	4,606	283,212	4.00	4.61
August	2,675	950	1,605	98,688	1.60	1.84
September	950	500	666	39,630	.67	.74
October	1,500	425	728	44,763	.73	.84
November	7,300	700	2,612	155,425	2.61	2.91
December	5,500	1,200	2,941	180,835	2.94	3.39
The year	7,300	425	2,546	1,844,774	2.50	33.88
1900.						
January	6,100	1,420	2,369	145,664	2.37	2.74
February	1,550	1,000	1,199	66,589	1.20	1.25
March	4,310	1,090	2,720	167,246	2.72	3.14
April	5,200	1,690	2,953	175,716	2.95	3.29
May	5,200	1,550	3,166	194,670	3.17	3.66
June	3,010	1,090	1,806	107,464	1.81	2.02
July	1,000	470	640	393,521	.64	.74
August	530	370	423	26,009	.42	.48
September	590	390	448	26,658	.45	.50
October	2,000	390	721	44,332	.72	.83
November	1,420	910	1,189	70,750	1.19	1.33
December	5,800	1,300	2,711	166,693	2.71	3.13
The year	6,100	370	1,695	1,585,312	1.70	23.11

a Approximate.

Estimated monthly discharge of Yakima River at Union Gap, Wash.

[Drainage area, 3,300 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1896.						
August	2,600	1,170	1,650	101,454	0.50	0.58
September	1,170	910	1,071	63,729	.32	.36
October	910	840	860	52,879	.26	.30
November	45,550	910	7,652	455,325	2.32	2.58
December	10,430	2,320	5,162	317,399	1.56	1.80
1897.						
January			a 2,100	129,125	.64	.74
February			a 3,000	166,612	.91	.95
March	4,738	1,650	2,472	151,998	.75	.86
April	27,550	4,738	15,004	892,798	4.55	5.07
May	23,954	11,621	15,685	964,439	4.75	5.47
June	10,826	4,738	7,109	423,014	2.15	2.40
July	6,365	1,650	3,291	202,357	1.00	1.15
August	1,440	915	1,168	71,818	.35	.40
September	915	705	817	48,615	.24	.27
October	1,020	705	810	49,805	.24	.28
November	25,135	915	5,274	313,824	1.60	1.79
December	11,220	2,330	3,969	244,046	1.20	1.38
The year			5,058	3,658,451	1.53	20.76
1898.						
January	8,270	1,894	3,350	205,965	1.02	1.18
February	22,246	1,775	6,804	377,875	2.06	2.14
March	6,989	2,818	4,538	279,033	1.38	1.59
April	12,446	3,000	6,901	410,637	2.09	2.33
May	18,500	8,270	12,388	761,713	3.75	4.33
June	15,091	5,250	9,514	566,121	2.88	3.21
July	5,250	2,170	3,480	213,978	1.05	1.21
August	2,170	885	1,364	83,870	.41	.47
September	985	685	855	50,876	.26	.29
October	1,775	685	1,300	79,984	.39	.45
November	2,644	1,315	1,971	117,282	.60	.57
December	10,059	985	1,988	122,238	.60	.69
The year	22,246	685	4,538	3,269,542	1.37	18.56
1899.						
January	10,500	2,000	4,813	295,940	1.46	1.68
February	8,050	3,500	4,810	267,134	1.45	1.51
March	3,900	2,450	3,006	184,833	.91	1.05
April	6,300	2,600	4,273	254,261	1.29	1.44
May	13,750	4,525	9,424	579,459	2.85	3.29
June	17,011	9,800	13,346	794,142	4.04	4.52
July	9,800	4,525	7,554	464,477	2.28	2.62
August	4,525	2,600	3,299	202,848	.99	1.14
September	2,450	1,605	1,920	114,248	.58	.64
October	2,900	1,355	1,888	116,089	.57	.66
November	12,030	2,300	4,711	280,324	1.42	1.58
December	14,180	2,150	5,951	365,913	1.80	2.08
The year	17,011	1,355	5,416	3,919,667	1.64	22.21
1900.						
January	19,150	4,000	8,752	538,139	2.65	3.05
February	4,800	3,060	3,770	209,375	1.14	1.19
March	11,450	3,500	7,474	459,558	2.26	2.61
April	11,800	4,800	7,747	460,978	2.35	2.62
May	10,750	3,750	7,066	434,471	2.14	2.47
June	4,800	2,800	3,828	227,782	1.16	1.29
July	2,600	1,150	1,635	100,532	.50	.58
August	1,150	650	876	53,863	.27	.31
September	1,350	850	1,090	64,859	.33	.37
October	6,600	950	2,243	137,917	.68	.78
November	4,250	2,800	3,472	206,598	1.05	1.17
December	13,550	4,250	7,092	436,070	2.15	2.48
The year	19,150	650	4,567	3,330,142	1.39	18.98

a Approximate.

UNDERGROUND WATERS.

GENERAL CONDITIONS.

Often the concealed water is the most important supply of a region. If the surface is hard and not well adapted to receive moisture, a large part of the rainfall is contributed to the run-off; or if the surface is poorly drained, evaporation may claim a large share. On the other hand, where the soil is sandy and open in texture, the percentage of rainfall that sinks into the ground may be considerable. The course which such waters take after their disappearance beneath the surface depends upon geologic conditions. The presence of an impervious subsoil or rock floor will cause the retention of the moisture immediately beneath the surface, where it is within the reach of vegetation, and is, through the agency of plants and the action of capillarity, brought again to the surface and eventually evaporated, never contributing to any general storage of underground waters. In the Yakima Basin these conditions are found at many localities where deposits of fine soil, of alluvial or possibly of æolian origin, directly overlie the solid basalt. The northern slope of Umptanum Ridge is a good example, and it is there that the "dry" cultivation of wheat and barley is found to be practicable.

GROUND WATER.

More commonly the water seeps through the subsoil and seeks lower levels, directed in its course by the relative porosity of the various layers of soil or rock encountered. Where the underground water is unconfined and practically free to keep its own level, it may be termed ground water. Such conditions obtain where the impervious bed simply underlies the water-carrying strata. Thus the ground water may be said to form an underground drainage system roughly comparable to the system of surface streams. In the underground system, however, there is less concentration into streams, and the rate of flow is much less rapid, since the water circulates through the minute spaces between soil particles or rock grains. Where relatively impervious rocks are traversed by joints or fissures these openings become channels for underground waters, and then the conditions are more favorable for rapid flowage than in the ordinary pore openings of the most porous rock.

The availability of the ground water is governed by geologic relations. The character and attitude of the different rock formations directly affect the position of the water table or the upper surface of the zone in which the soil and rock are saturated with water. Where porous sandstone or loose open sands and gravels overlie beds of clay or impervious rock, the zone of easy passage by the underground waters is well defined. If such water-carrying beds are near the sur-

face they constitute the source of supply for surface wells; and if the water-saturated beds reach the surface the ground water is returned to the surface drainage system through the agency of springs. Innumerable examples of the utilization of the underground supply of water in the Yakima region could be cited. All of the surface wells of the lower valleys derive their supply from the water-saturated sands and coarser alluvium. In localities where the wells are close to the stream it is probable that the well water is derived from the underflow or underground portion of the stream. This is plainly the case where the surface stream is seasonal in character and only the underflow persists through the summer. The North Fork of Cowiche Creek is such a stream, and shallow wells have been dug in the stream bed to reach this underflow and thus insure a water supply during the dry season. As an example of the use of the available ground water in rock close to the surface, the tunnel driven horizontally into the hill slope on a ranch on Wenas Creek (sec. 11, T. 15 N., R. 17 E.) may be cited. The water which permeates the sandstone is in this manner collected and piped to the house. In the same valley these porous sandstone beds also feed numerous surface springs.

ARTESIAN WATER.

The second class of underground water is water under pressure. Where confined within a porous bed between impervious strata the

FIG. 6.—Diagrammatic section of artesian basin.

action of the water is different from that of the ground water just described. When such a water horizon is reached by a well the confined water rises and is said to be artesian, whereas ground water simply flows into a well opening, never rising above the surface of the zone of saturation. The degree to which the water possesses the artesian property is controlled by the pressure, and this is most important, since upon it depends whether the artesian well is a flowing or a pumping well. Fig. 6 illustrates an artesian basin, and shows the relation of the porous bed and the impervious strata.

The essential conditions of artesian water are geologic and topographic; that is, they involve both the underground structure and the surface configuration—the occurrence of permeable or porous rock beds or strata between other beds relatively impervious, the disposition of these strata in basin-like form, and the relatively high outcrop of the edges of the permeable strata. It will be noticed that two of these conditions depend upon geologic structure, while the third relates to the topographic features of the region.

The presence of a porous stratum between impervious strata is

necessary, because it constitutes the area of accumulation or storage of underground water. The water-carrying bed may be sand or sandstone, the interstices of which afford ready passage for the circulating waters. When confined by underlying and overlying impervious rocks, such as clay, shale, or some dense and compact igneous rock, the porous stratum becomes saturated with water, which can find outlet only through the porous bed itself.

The second condition mentioned as essential is the basin or trough structure of the rock strata, shown in fig. 6. This structure is a controlling factor, because the water-carrying strata must in no place reach the surface at a lower level than the elevation of the well. A lower outlet would prevent the storage of water under pressure, with the result that the water would fail to rise in the well, in which event the supply tapped would not be artesian, but of the nature of ground water, as already explained.

The third controlling condition is the existence of an adequate source for the artesian water. The outcrop of the porous beds at the surface constitutes the area of supply or imbibition. Here surface and ground waters pass downward and enter the artesian basin or area of accumulation. To adopt a common illustration, the outcrop of the water-carrying bed may be compared to the intake of a city water main at the reservoir; thence the city's water supply is carried beneath the surface, but is available wherever a surface pipe taps the main and brings the water to the surface again, the pressure at any hydrant being directly dependent upon the elevation of the reservoir. This comparison of an artesian basin to a city water system of the gravity type may be found helpful to the practical man.

If all of the conditions specified obtain in a region, an artesian water supply is assured, and the water which is stored in the artesian basin can be tapped by a well driven through the confining cover, thus affording an outlet for the water which saturates the porous beds. The height to which the artesian water will rise in the well is dependent upon the head or pressure, which in turn is directly controlled by the elevation of the upper end of the water body, or the point where the water-saturated beds reach the surface. If the mouth of the well is relatively lower than the point where the beds receive their supply, the pressure will be sufficient to force the artesian water to the surface, and the well will be a flowing well. If, however, the mouth of the well is higher than the outcrop of the water-carrying beds, the water in the well will not reach the surface, and pumping will be necessary. Friction within the water-carrying beds and the well casing of course enters as a factor, slightly decreasing the pressure.

The facts which bear directly upon these three essentials of artesian water must be ascertained in different ways and with varying degrees of success. The area of accumulation or storage is subterranean, and therefore is known only through "logs" or well records. Geologic

observations of the surrounding country—the more widely extended the better—also afford a basis for a comparatively accurate knowledge of the underground conditions. This is equally true of the second factor, the structure. Accurate mapping of the geologic formations, with careful study of their structure, enables the geologist to estimate the probability of the presence of an artesian water supply. The third condition is directly available for study, since the area of supply or outcrop of the porous beds is at the surface, and observation can be made of the areal extent of the outcrop and the amount of precipitation, which factors directly affect the supply of water and the storage area below, and a knowledge of them is necessary to any discussion of the amount and constancy of an artesian water supply.

ARTESIAN BASINS.

In the light of the foregoing discussion of general principles it may be well to describe now certain areas of central Washington which possess, or are thought to possess, artesian water. At present there is known within this region no artesian basin which can be compared to such basins in other parts of the country. As before stated, central Washington is unique in the geologic structure of its mountain ridges and valleys. The conditions which exist in the one known artesian basin are peculiar, and for that reason require special consideration. The presence of a supply of artesian water where it could hardly be expected renders careful study of the geologic conditions imperative. To this end a description of the Atanum-Moxee Basin is necessary, and the knowledge that is acquired from a study of that artesian basin can be applied to the other areas where water is desired.

ATANUM-MOXEE BASIN.

The Atanum and Moxee valleys occupy the synclinal fold or trough described on page 25. The structure of this composite valley becomes its most important feature in relation to its value as an artesian basin, and it will be seen to possess the form essential to make it a reservoir for artesian water. The valley itself may be described as canoe shaped, but the trough structure of the underlying rocks is more accentuated, and may better be compared to a flat-bottomed scow. For 15 or more miles along the central part of this rock fold the beds have little slope or dip, but at each end there is a rather sudden change to an upward slope. Thus, while 5 miles east or west of Yakima River the base of the Ellensburg sandstone or the top of the Yakima basalt is at a depth of from 1,000 to 1,200 feet, a few miles beyond it is much nearer the surface. In Atanum Valley the slope of the bottom of this rock trough is known from a well record and from surface observations. Less than 2 miles east of the village of Atanum the upper surface of the basalt is more than 1,200 feet

beneath the valley floor, while 6 miles west of that place the basalt appears at the surface. This represents a total upward slope at this end of the trough of more than 1,700 feet, while west of Tampico the basalt sheets slope upward even more rapidly, until the top of the inclosing ridge is reached. The outcrop of the basalt for a few miles along Atanum Creek below Tampico is due to a step-like interruption in the general eastward slope of the rocks at that point. This is important, as will be explained further on, because the water horizon near the base of the Ellensburg sandstone is here brought to the surface.

At the sides of the Atanum-Moxee Basin the upward slope of both the surface and the rock beds is quite abrupt, but the dip of the rocks is steeper than the slope of the surface. In the vicinity of Union Gap and westward for a few miles along the southern wall of the basin, the Ellensburg sandstone, wherever observed, is sharply upturned, and dips of 50° to 80° can be seen, while at a few points the rocks stand in a vertical position or are slightly overturned. This is also true on the north side of Wide Hollow, near Naches River.

While this area has the essential basin structure, it will be noticed at once that Yakima River has cut across the rim of the basin at points approximating 1,000 feet above sea level. At that level, then, the lower beds of the Ellensburg formation occur under the alluvium of the river bed, and, since these beds constitute the water horizon, it presumably would follow that the artesian basin would be tapped at that level. Furthermore, these being the lowest points in the Atanum-Moxee Valley, no flowing wells could reasonably be thought possible there; but such wells do exist, and will be described further on, and as they occur more than 100 feet higher than the sea level, it is evident that the artesian basin is not tapped.

So anomalous a condition of course requires an explanation. Two hypotheses may be advanced to account for the absence of leakage at the river level. The cover of fine alluvium may be so impervious as effectually to seal the exposed edges of the water-carrying beds. It has been recognized that the fine-grained sediment of the flood plains of a river sometimes is so firmly compacted as to be practically impervious. In view of the fact, however, that surface springs occur along some of the creeks in this vicinity, it seems hardly probable that the alluvium of Yakima River is sufficiently compact to prevent the upward passage of artesian water with the pressure that it is known to possess elsewhere in the basin. An explanation of this sealing up of the lower beds of the Ellensburg formation is more probably to be found in the structure of the synclinal fold. The steep dips observed along the sides of this fold in the vicinity of Yakima River is evidence of a certain degree of compression of the fold. Especially is this apparent where the lower strata are overturned. Such lateral pressure must have its effect upon the rocks, and it appears quite probable that the sandstone, which in other parts

of the basin is open textured and porous, may here have become so compacted as to be relatively impervious.[1] In this way the lower strata, which constitute the water horizon along the bottom of the trough, are so changed in character along the sides as to cease to be water-bearing. Were it not for this feature the artesian basin would be drained at about 1,000 feet above sea level, and flowing wells would be possible at no point within the Atanum-Moxee Valley. As it is, however, more than a score of wells with flowing water prove the value and importance of this artesian basin. These wells will be described in a later section.

The structure of the basin in the immediate vicinity of the Moxee wells can best be illustrated by deformation contours. Fig. 7 (p. 48) shows, by means of contours or lines of equal elevations, the elevation above sea level of the lowest water-carrying beds, which mark approximately the base of the Ellensburg formation. The depths at which the water horizon is found in the different wells, together with observations made along the sides of the valley, constitute the basis for this map. It will be noticed that the syncline is unsymmetrical, having a steep side on the south and a gentle slope on the north.

WENAS-SELAH BASIN.

This transverse valley, as already noted, has somewhat the same general topographic and structural relations as the Atanum-Moxee Valley. The points of difference, however, are those which are most important with reference to the artesian water supply. The synclinal fold of this valley is much more shallow and gentle than the Atanum-Moxee trough. Taking the upper surface of the Yakima basalt as a datum plane, the lowest part of the Wenas-Selah syncline is not much below 1,000 feet above sea level, whereas in the Atanum-Moxee fold the basalt surface at its lowest point is undoubtedly considerably below sea level. This difference is significant, since it means that Yakima River not only cuts across the sides of the fold, but has cut down almost to the base of the Ellensburg sandstone along the bottom of the trough. Of course such a relation involves a draining of the basin by the river, since, as in all of these transverse folds, the lowest portion of the syncline appears to be in the vicinity of Yakima River.

As can be seen on the geologic map (Pl. II), east of Yakima River the syncline is so high, with reference to the river, that the Ellensburg formation is largely wanting, and the valley is floored with basalt. West of the river the Ellensburg sandstone is present in great thickness, and it is in this syncline that the section given on pages 17 to 21 was measured. In the valley of Wenas Creek the geologic

[1] This hypothesis is supported by the occurrence of sandstone northwest of North Yakima at a point where the lower beds of sandstone are overturned. There it is compact enough to be quarried for building stone. Along the bottom of the trough these same beds are represented by soft sandstone and loose sand which in places is almost a quicksand.

relations at first sight seem to warrant investigation. The sandstone series extends upward on the ridge to the north, while to the south the same formation rises in high cliffs. The basin structure is present, with the elevated outcrop of the water-bearing beds; but again it is to be noted that the stream occupying this synclinal valley has cut down to very near the base of the Ellensburg, and in fact reaches it near where the main Wenas–North Yakima road turns southward and crosses the creek at the Cleman ranch.

In 1900 some work was done toward sinking a well on the Stauffer ranch, in Wenas Valley (sec. 34, T. 15, R. 18). The elevation of this well is approximately 1,500 feet, and it was sunk about 400 feet in Ellensburg sandstone. Ground water in good amount was found at a depth of 152 feet. The depth to which the sandstone was found to extend points to a shallow basin existing between the southern slope of the anticlinal ridge north of Wenas Valley and the exposure of basalt along the creek 2½ miles southeast of the well. Any water in this basin, however, would find a surface outlet near the creek level, so that no artesian supply would exist to be tapped by a well having an elevation of 1,500 feet. These relations are therefore unfavorable, and the statements that have been made are corroborated by the occurrence of large springs near Wenas Creek, on the Cleman ranch, at just the point where the lowest beds of sandstone must reach the alluvium-covered valley floor. Mr. Cleman states that the water of these springs is much warmer than the creek water. As mentioned on page 38, surface springs occur elsewhere along this creek, affording further evidence that the water of the sandstone finds a natural outlet throughout the length of this valley and is not stored in an artesian basin. It is indeed probable that if the water could be shut off in the upper part of Wenas Valley, the contributions from springs in the lower valley would be sufficient to maintain a small stream in the lower course of the creek.

There is a possibility that water may be stored in the lowest beds of sandstone which underlie the latest flow of Yakima basalt. These beds are exposed on the ridge north of Wenas Creek. As this sheet is at least 100 feet thick at this locality, it is quite doubtful whether the expense of penetrating it would be warranted by the prospect of finding water below, especially in view of the fact that the bed of sandstone beneath the basalt is often only a few feet thick and would not carry any considerable amount of artesian water. Furthermore, since the lower bed is cut by Yakima River on the north side of Selah Ridge, it is quite possible that the water content of this bed is also tapped and that artesian conditions do not obtain.

RYE GRASS FLAT.

On the north side of Selah Valley there is a smaller valley, known locally as Rye Grass Flat. As can be seen on the map, Pl. II, this flat

is separated from the main valley by a low ridge, across which, however, a small seasonal stream has cut a narrow channel. As is universally true in this region, the topographic valley occupies a structural basin which is well defined. Along the southern and southwestern slopes of this basin the Ellensburg sandstone and shale plainly outcrop, with northern and northeastern dips of about 20 degrees. Several hundred feet of the Ellensburg formation are thus exposed, underlain by the basalt which forms the inclosing ridges. On the north side of the basin the sandstone is seen dipping to the south, but at a much lower angle.

In the summer of 1900 a well was driven to a depth of 270 feet in sec. 15, T. 14, R. 20, near the western end of Rye Grass Flat. At 54 feet surface water was found in what appeared to be alluvium. Here the fine alluvium or soil is 18 feet deep, with bowlders below. In its lower portion this well is undoubtedly in the Ellensburg sandstone, but it has not reached the lowest beds. The basin structure is favorable to the storage of artesian water, and where the well is located the drainage outlet of the valley is not so low as to prevent the water rising to within a short distance of the surface. The stream, however, appears to receive some water from this basin in even the middle of summer, and it is therefore quite doubtful whether the conditions are favorable for a flowing well. The well will undoubtedly be continued to a greater depth, as the search for artesian water in Rye Grass Flat is well worth the necessary expenditure, since there is considerable land of excellent quality that would become very valuable if water could be found.

COWICHE VALLEY.

The valley of Cowiche Creek contains several thousand acres of land that only requires water to make it valuable. Barley and wheat are raised there without water, but only with a moderate degree of success. On several ranches along the south fork of the creek irrigation is practicable and excellent crops of alfalfa are raised. On the north fork of the creek attempts have been made at a few points to store the waters that flow so abundantly in the spring months, and surface wells have also been dug and windmills erected.

Study of the geologic relations of this topographic basin shows that it is not in any sense an artesian basin. As can be seen, it is in reality only a portion of the large synclinal valley that lies north of Cowiche Mountain and Selah Ridge. The valley is inclosed on the northeast by the andesite plateau, but this is merely a surface flow superimposed upon the eroded surface of the Ellensburg sandstone, and therefore offers no obstruction to the flow of underground water within the sandstone beds. The conditions are therefore unfavorable for finding artesian water. However, the supply of ground water on the lower levels of the valley may be further drawn upon, while the strength of

the prevailing winds of summer appears to be very favorable for windmill irrigation.

OTHER AREAS IN CENTRAL WASHINGTON.

At several other localities in central Washington attempts have been made to find artesian water. So far as the areas come within the region the geology of which has been described in this paper, the foregoing discussion may be helpful in suggesting the probability of finding water, and the few general statements which follow may aid in deciding whether or not to prospect for it.

The Ellensburg sandstone is the water-carrying formation, and generally the best water horizon is found near its base. The transverse synclinal valleys along Yakima River would possess a structure favorable to the collection and storage of underground waters were it not that the river has cut across their lowest parts, so that only under exceptional circumstances are they artesian basins. The great thickness of the Yakima basalt makes it inadvisable to prospect for artesian water in that formation. While it is often in the basalt areas that there is the greatest need of water, the chance of finding artesian water in it is far too small to warrant the great expenditure that would be necessary. The springs found along the flanks of the basalt ridge are almost without exception cold-water springs, and therefore do not point to any deep-seated supply.

The only other area that deserves special mention is Kittitas Valley. This broad valley has the basin structure, and from its great extent it appears well suited to the accumulation of underground waters. The water-bearing beds extend up on the slopes of the inclosing ridges, and must receive contributions from the precipitation over a large area. In the central part of the valley the water horizon lies at a depth of several hundred feet. As reported by Professor Russell,[1] the Sanders well, an experimental well about 2 miles northwest of Ellensburg, reached basalt at about 700 feet. When abandoned it had water at 40 feet below the surface. The evidence which it afforded was unfavorable, yet it is quite possible that this well, like many others, was drilled by an inefficient well man, and that the record is untrustworthy. The loss of tools is sometimes the occasion for falsifying the log, in order that the well may be abandoned without loss to the operator.

At the Clerf Spring, at the east end of the valley, water with considerable pressure is found flowing upward through the basalt. In the summer of 1900 the drilling of a well was commenced in the immediate vicinity of this artesian spring, about 10 feet higher, and it seems probable that not far from the surface water will be found which can be used to augment the stream already issuing from the spring. The spring has also been enlarged, its flow being increased fourfold.

[1] Bull. U. S. Geol. Survey No. 108, p. 69.

The water is seen to issue from crevices in the sandstone and the honeycombed basalt beneath. It has a temperature of 68°, and may be derived from interstratified sandstone beneath an upper sheet of basalt. If any considerable flow of water is developed at this locality it can all be used to good advantage in the eastern part of Kittitas Valley.

The gap where Yakima River cuts through the rim of the Kittitas Basin, 5 miles below Ellensburg, is of course the critical point in the structure of the basin. The exposures of the Ellensburg sandstone at this locality are poor, but they are sufficient to show that the lower beds are sharply upturned. Immediately south of the edge of the valley a transverse fault gives further evidence of marked dynamic action on this side of the basin. Whether this is sufficient to prevent tapping the artesian basin, as appears to be the case at Union Gap, south of the Atanum-Moxee Basin, can not definitely be stated. The possibility of a true artesian basin being found to exist here appears, however, sufficient to encourage the drilling of another experimental well in Kittitas Valley. This should not be done by a tyro, but by the most experienced and reliable well man available.

Larger irrigation canals taking water from upper Yakima River may possibly be built in the future, which would obviate the necessity for artesian water in this valley, in which event it would not be economical to expend any money in searching for an artesian supply.

ARTESIAN WELLS OF ATANUM-MOXEE BASIN.

GENERAL FEATURES.

Within ten years more than thirty artesian wells have been put down in Moxee Valley. As can be seen from the accompanying map, fig. 7, the principal wells are within an area of about 6 square miles. They are from about 600 to more than 1,000 feet in depth, and have flows varying from 0.05 to 2 second-feet. The water is warm, ranging from 67° to 76° F. Sulphureted hydrogen can usually be detected in it, but not in any great quantity, and being clear and apparently free from other impurities, it is used for domestic purposes as well as for irrigation. Owing to the temperature of the artesian water, in winter the cattle prefer it to stream water.

The wells show varying degrees of skill on the part of the well borers. In general they have been cased only as demanded in the progress of sinking them, and often the casing has been drawn in order to save it. Such economy is likely to be followed by a loss of flow through leakage or caving. Many of the wells have not been located so as best to serve the purposes of irrigation. It is worth noting, however, that the tendency in this region is toward greater care in the sinking of artesian wells, and the latest wells are much superior to those put down earlier.

The logs of the wells, when preserved, have little value as records of the beds penetrated by the bit. The fineness of the material brought to the surface prevents very accurate determination, and often the designation of the beds as shale, sandstone, or basalt is purely a guess based upon the rate of progress made by the drill. The attempt to use these records to construct a general section of the Ellensburg formation under Moxee Valley has proved fruitless, and on that account the logs are omitted from this report. In many logs basalt is reported at several horizons, whereas along the slopes of the ridges bordering the valley only one sheet of basalt is known to be interbedded with the sandstone. It is very probable that some of the conglomerates of the Ellensburg formation, containing, as they do, large bowlders of hard andesite, as well as some of basalt itself, have been mistaken for basalt.

The logs which record the depth at which the different flows of water are tapped are more valuable. While data on this subject can not be obtained for every well in the valley, the information available is sufficient to show that it is possible to correlate the different flows tapped by wells some distance apart. The water horizons thus indicated appear to afford trustworthy data for the determination of the form of the basin.

The table on page 49 shows the relative position of the various flows in some of the wells. From this table it will be seen that the first principal flow and the lowest flow are separated by intervals of from 148 to 235 feet, and these principal flows can be recognized throughout the field. Smaller flows occur between these two, but they do not seem to be so persistent. In certain of the wells small flows also were encountered above the first principal flow, even within 180 and 200 feet of the surface.

The plat (fig. 7) showing deformation contours is based in large part upon these well records, and shows in a graphic manner the configuration of the floor of the artesian basin. The local ridge along the center of this basin, in sections 8 and 9, has been noticed by well men, since there the water horizons are found nearer the surface. Reference to this map will show that there is a westward dip of the water horizon, amounting to about 300 feet in the mile along the line between sections 5 and 8. The deformation also shows how the Clark well in section 31, and the Sauve well in section 8, reach the water horizon at almost exactly the same level. A glance at the map will show why the well in section 12, near the west line of section 7 of the next township east, as stated further on, did not find water at a depth of 700 feet. The lower water horizon is probably several hundred feet below sea level, so that even the upper flow could not be expected at a depth less than 1,000 feet, and it seems quite possible that this well might be deepened 500 feet before water is obtained. It should be stated that this map, showing the position of

the water horizon or lower flow, is based upon so scanty data that it must not be considered as showing the exact elevation of the floor of the basin, but only its approximate position and general form.

DESCRIPTIONS OF WELLS.

The table on the next page is a list of the principal wells, with the more important data concerning them. Fig. 7 will assist in locating the wells. Several of the earlier ones have been omitted from the map and from the list, since they have ceased to flow or are so nearly dry as to be of little value. The wells which are dry are outside of the area of flowing wells in sec. 32, T. 13, and in secs. 3, 4, and 10,

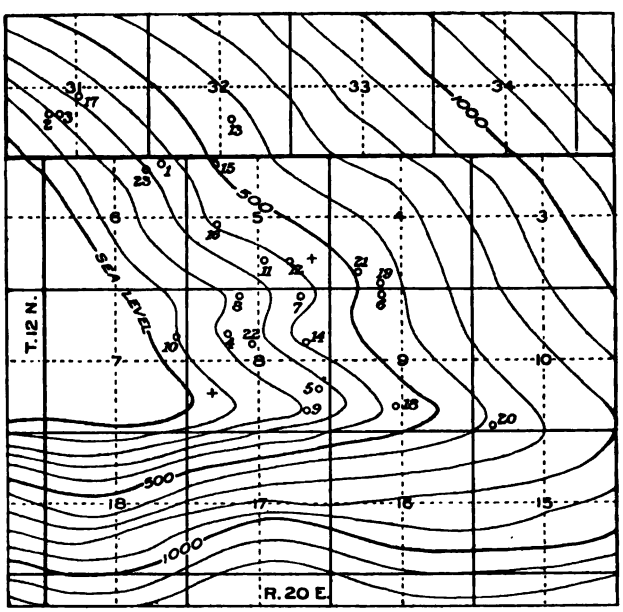

FIG. 7.—Plat showing form of Moxee Basin and location of artesian wells.

T. 12. With one exception the elevations of the wells are approximate, being based on aneroid measurements referred to the United States Geological Survey bench mark at North Yakima, which is 1,067 feet above sea level. The elevation of the Wilson well in Wide Hollow was accurately determined by a level line run by Mr. Sydney Arnold, connecting with the United States Geological Survey bench mark 1066, 4 miles east of Atanum. The location of this well is outside of the Moxee area, but it can be seen by reference to the general map, Pl. II. The measurements of flow were made in April, 1901, by Mr. Sydney Arnold, a weir being used except where otherwise stated. The numbers of the wells given in the table correspond with the numbers on the map.

List of wells in Atanum-Moxee Basin.

No.	Name of well.	Location. Sec.	T.	R.	Approximate elevation.	Depth.	Flow.	Depth to principal flows.				Temperature of water.
					Feet.	*Feet.*	*Sec.-ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Deg. F.*
1	Clark No. 1	6	12	20	1,110	940	1.34	700	(?)	(?)	(?)	73.2
2	Clark No. 2	31	13	20	1,130	1,026	.15	800	(?)	(?)	1,000	76.2
3	Clark No. 3	31	13	20	1,120	1,000	.52	.....	.....	.....	.....	75.6
4	Longevin No. 1	8	12	20	1,070	637	.40	637	.....	.....	.....	72.2
5	Haines	8	12	20	1,145	902	.984	702	760	790	902	72.2
6	Bradford	9	12	20	1,155	623	.904	366	.....	623	.....	73.2
7	Dickson	8	12	20	1,095	525	(a)	515	.....	.....	.....	70.7
8	Gano	8	12	20	1,075	851	(a)	649	.....	851	.....	76.0
9	Sauve	8	12	20	1,155	1,020	.475	832	(?)	(?)	1,020	75.2
10	Ellens No. 1	7	12	20	1,065	835	.13	835	.....	.....	.....	73.2
11	Holland No. 1	5	12	20	1,100	736	b 2.00	568	688	736	.....	76.0
12	Regimbal	5	12	20	1,105	689	1.09	525	640	686	.....	73.2
13	Buwalda	32	13	20	1,150	653	.05	424	508	550	600	67.2
14	Ellens No. 2	8	12	20	1,100	676	(a)	424	504	657	.....	.....
15	Buwalda and Haines	5	12	20	1,140	636	b .566	475	575	636	.....	69.2
16	Holland No. 2	5	12	20	1,115	686	.35	520	620	686	.....	74.7
17	Clark No. 4	31	13	20	1,140	960	.197	660	770	820	.....	73.2
18	Allwardt	9	12	20	1,185	809	.64	.....	c 615 to 718	752	.....	72.2
19	Deeringhoff	4	12	20	1,165	625	.....	390	.....	625	.....	73.2
20	Rein	10	12	20	1,195	631	.485	+630	.....	.....	.....	66.3
21	Hill	4	12	20	1,170	225	.....	206	.....	.....	.....	.....
22	Longevin No. 2	8	12	20	1,080	836	.807	530	(?)	820	.....	72.7
23	Peck	6	12	20	1,105	818	b 1.10	620	(?)	818	.....	.....
24	Wilson	29	13	18	1,165	1,267	d .75	800	1,000	1,050	.....	80.0

a Well closed April, 1901.
b Approximate measurement with current meter.
c Six flows.
d Estimated.

Most of these wells deserve further description, and for this purpose they have been grouped according to locality, and will be discussed in the order of the section in which they are situated, beginning with sec. 4, T. 12 N., R. 20 E.

WELLS IN SEC. 4, T. 12, R. 20.

The Deeringhoff well, No. 19 of list, is the more important well in this section. It was completed in April, 1900. At that time the water rose 36 feet in an open pipe, and the flow reported was 56 cubic inches, but it is thought to have since diminished somewhat. The well is cased from 200 feet below the surface to 535 feet, thus cutting off the first flow. The casing ranges from 5⅝ inches to 3 inches.

The other well in this section is No. 21, the Hill well. This well was drilled by Mr. Stone, the former owner of the land, but was not completed, owing to the loss of the drill. At 206 feet a small flow was tapped, which is used.

WELLS IN SEC. 5, T. 12, R. 20.

This section contains four of the more important wells of the valley.

Well No. 12 is on the ranch of F. Regimbal, being located near the northeast corner of the southwest quarter of the southeast quarter. It was put down by Messrs. Buwalda and Haines, in 1898, and taps three flows. There is a casing through 260 feet of sand, but this is

above the first flow, so that none of the flows which are in sand and sandstone are cased.

Well No. 11 is in the northwest corner of the same 40-acre lot, and was drilled the same year by Buwalda and Haines. This well is cased for 344 feet in its upper portion, but in the summer of 1900 there was considerable leakage around the casing, a trouble that it will be difficult to remedy. The three flows are not cased. The well belongs to the Holland Company.

Well No. 16 is near the northeast corner of the northwest quarter of the southwest quarter of the section. This well was completed in 1899. Shale in the upper portion of the well caved, so that 4½-inch casing was put down as far as 490 feet. The three flows are not cased.

Well No. 15 is on the fractional northwest 40 acres of this section. It was completed in June, 1899, by Buwalda and Haines, and is owned by a company. The stock is divided into 6 shares, each share supposed to represent water for 20 acres. The three flows are tapped by this well and are not cased.

A new well, indicated by the cross on the map, is being drilled east of the Regimbal well. In March, 1901, it was reported to be down 347 feet.

WELLS IN SEC. 6, T. 12, R. 20.

The two wells in this section are very important, one being almost the oldest well in the district, and the other being the last one completed.

The Clark well No. 1, as it is termed, is not far from the northeast corner of the section. Pl. VI shows the appearance of this well when completed, in 1893, as photographed by E. E. James, of North Yakima. Unfortunately, exact measurements of the flow and pressure at the time of its completion are lacking. In 1897 Mr. Clark reported its discharge to be 120 miners' inches. The testimony of those who have known the well for several years is to the effect that there has been considerable decrease in pressure and flow. In April, 1899, Mr. Sidney Arnold found the discharge to be 1.435 second-feet. This well taps the three principal flows, and is 6 inches in diameter at the mouth. The smallest casing is 4½ inches. The well cost $2,000.

The Peck well, No. 23, is about 200 yards west of Clark well No. 1, in the next quarter. This was not completed at the time of the field work, but Mr. Haines, who drilled it, reported it finished early in the present year (1901). It taps the same flows as the Clark well, but at slightly greater depths. This shows the western dip of the water horizons, and accords with the basin structure shown in the other sections.

WELL IN SEC. 7, T. 12, R. 20.

Well No. 10, the only well in this section, is close to the east line of the section. It was put down in 1899, by Mr. Ellens, the former

CLARK WELL NO. 1, MOXEE VALLEY

superintendent of the Holland Company. It is cased, but has only a small flow. The pressure is sufficient to raise the water in a 2-inch pipe high enough to carry it into the house on the Holland ranch.

WELLS IN SEC. 8, T. 12, R. 20.

This is the section with the greatest number of wells, having seven already down and one being drilled in February, 1901.

Well No. 4, on Mr. Longevin's ranch, is the oldest well in the section. It was drilled in 1893, and is comparatively shallow, tapping the first flow only. It is a small well, being only 3 inches in diameter.

Well No. 22, farther east on the same ranch, is deeper and penetrates to the third flow. This well is cased down to a depth of 730 feet, the first and second flows being shut off. It was drilled in 1900 by Mr. C. H. Haines.

Well No. 5 is near the east line of the section, on the ranch of Mr. Haines. It was completed to a depth of 702 feet in 1896, but was deepened later, and now taps four flows. It is cased, with casing from 6 to 4 inches in diameter, as far as 890 feet. The casing is split at the first, second, and third flows, all of which are in the 4-inch casing.

Well No. 9 is in the southeast quarter of the southeast quarter, on the ranch of J. Sauve. It was driven to a depth of 835 feet in 1897, by Mr. H. J. Spratt, but was deepened in 1899 and 1900, by Mr. Haines, to 1,020 feet, with the effect of approximately doubling the flow. The casing at the bottom is only 2 inches in diameter.

Ellens well No. 2, No. 14 of the list, is in the southeast quarter of the northeast quarter of this section. It taps three small flows, and is not cased below 225 feet.

The N. J. Dickson well, No. 7, is in the northeast quarter of the northeast quarter, and was put down in 1897. It is the shallowest well of the district, and taps the first flow only, but it has a good volume, which is said by the owner to have increased since the other wells in the vicinity have been deepened to tap the lower flows. This well cost about $500.

Well No. 8 is nearly a half mile west of the Dickson well, on the ranch of James W. Gano. It was drilled in 1897 to a depth of 649 feet, where it tapped the first flow. The pressure was sufficient to raise the water 30 feet in an open pipe. Pl. VII is from a photograph of the well taken at that time. In 1900 this well was deepened to 851 feet, so that now it is supplied with water from both of the principal flows.

The new well in this section is in the northwest quarter of the southwest quarter. In March, 1901, it was reported to be down 640 feet.

WELLS IN SEC. 9, T. 12, R. 20.

The Bradford well, No. 6, is close to the north line of the section and only a few yards distant from well No. 19, in section 4. It was

drilled in 1897 to a depth of 386 feet, and in 1900 was deepened to 623 feet. The casing is 6, 4½, and 3½ inches in diameter. This is one of the few wells in the district provided with a valve by which the water can be shut off when not needed for irrigation.

Well No. 18 is on the Allwardt ranch, in the southwest quarter of the section. This well was drilled by Mr. Deeringhoff in 1899. Casing from 6⅝ to 4 inches in diameter extends to a depth of 730 feet, shutting off six small upper flows. The well appears to be in good condition. The flow is strong, and the well is so situated as to enable the water to be used to advantage.

WELLS IN SEC. 10, T. 12, R. 20.

Well No. 20 is near the southwest corner of this section. It was drilled by Mr. R. Rein, but is incomplete, although it has a small flow. The water from this well is the coolest artesian water in Moxee Valley, having a temperature of 66.3° F.

The three Steinway wells are in the southeastern part of this section. They were drilled in 1894 and 1895, but now are practically dry. One, however, flows a little. One of these wells was cased down to within 30 feet of the third flow.

WELLS IN SEC. 31, T. 13, R. 20.

The three wells in this section are the property of Mr. W. T. Clark. Nos. 2 and 3 were put down in 1892 and No. 17 was drilled in 1899. No. 2 is the smaller of the two wells near Mr. Clark's house, being 4–3½ inches in diameter, with a discharge probably less than half that of No. 3, which is 5 inches in diameter at the top. Wells Nos. 2 and 3 have practically the same elevation and are so close together as to have the same log. Mr. Clark reported the pressure from them in 1897, as determined by a gage test, to be 50 pounds. The cost of these two wells was more than $2,500. They are the oldest wells that are flowing to-day. Well No. 17 is a short distance to the northeast of the other wells, near the center of the section. It is not so deep, and its water is 3 degrees cooler. These three wells are only partially cased, which is believed to account for a decrease in discharge since they were put down.

WELLS IN SEC. 32, T. 13, R. 20.

Well No. 13 is in the northwest quarter of the southeast quarter, on the ranch owned by I. Desmarais. It was drilled by Mr. Buwalda, being completed in March, 1899, when the discharge measured 0.8 second-foot. It is cased to a depth of 428 feet, cutting off the first flow. The pressure at this well was low from the time of its completion, and in June, 1900, it ceased to overflow. The water stands 6 feet below the surface, and is conducted above ground by a short trench. A pump is used a portion of the time to irrigate higher parts of the ranch.

A well was drilled in this section, by Mr. W. T. Meigs, to a depth of

GANO WELL, MOXEE VALLEY.

623 feet, and a small flow of water was found, but the well is now dry.

MISCELLANEOUS WELLS.

The Yakima Land Company were the pioneers in putting down wells in Moxee Valley, well No. 1, section 3, being drilled in 1891. Three other wells were drilled by this company, in sections 3, 4, and 14, but not one of them is flowing at the present time.

In section 12, of the next township west, a well was drilled to a depth of 707 feet, and when the work was abandoned water stood at 70 feet from the surface.

Well No. 24 is near the southwest corner of the southeast quarter of sec. 29, T. 13, R. 18, on the ranch of George Wilson. It was completed in August, 1899, and cost $2,500. The expense of this pioneer well in Wide Hollow was met by a small company of ranch owners, the agreement being that in the event of the well proving successful all of the shares should be bought by Mr. Wilson. Thus the owner of the well was not obliged to assume the entire expense of what might have been a fruitless prospect for artesian water, while, on the other hand, the property owners, who shared the risk, now possess, at no expense to themselves, the important information of the presence of artesian water. The well is very successful, is of fairly good size, and is well cased, the diameter of the casing being from 5⅞ inches to 3½ inches. When completed it had a pressure sufficient to force a strong stream through the drill rods to a height of 42 feet above the surface, equivalent to 1,207 feet above sea level. The drilling was extended until basalt was struck, about 200 feet below the lowest flow and about 100 feet below sea level. The well has shown no variation in volume.

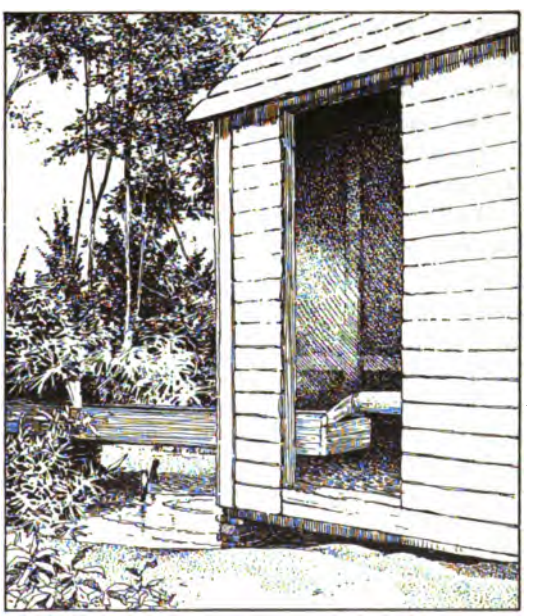

FIG. 8.—Wilson well, Wide Hollow.

AREA WATERED.

In the season of 1897 well No. 1 furnished water for the irrigation of 250 acres, and in 1900 it supplied eight small ranches with water,

the total area irrigated being 297 acres. This is plainly more than can satisfactorily be watered by this well, and the completion of well No. 23 will render unnecessary the use of water from the Clark well to serve the Peck ranch.

Wells Nos. 2 and 3 are reported to have irrigated 120 acres in 1897. In the summer of 1900 the flow from No. 2 was used on a market garden of 20 acres, while Nos. 3 and 17 were used to irrigate 90 acres of orchard, alfalfa, and other crops. Ninety acres of winter wheat were also irrigated on this ranch.

Wells Nos. 4 and 22, on Mr. Longevin's ranch, water 80 acres.

Well No. 5 is used for the irrigation of 85 acres on the ranch of Mr. C. H. Haines.

Well No. 6 supplies water for 40 acres, which is also the amount irrigated by well No. 7, but it is probable that in the future more land will be watered by the latter well.

The Gano well, No. 8, waters about 60 acres.

On the Sauve ranch 35 acres are watered by well No. 9, and it is the intention to increase this to 40 acres.

Well No. 10 is used simply to supply the Holland ranch with water for domestic purposes. The other wells belonging to this company (Nos. 11 and 16) furnish water for 115 acres of alfalfa on the same ranch, and after the soil is once thoroughly wet the supply probably will be sufficient for 200 acres.

Well No. 12 waters 120 acres on Mr. Regimbal's ranch.

The Buwalda well (No. 13) can supply water for 50 acres if a pump is used, and with the natural flow through the trench 25 acres can be reached on the Desmarais ranch.

In 1900 water from well No. 15 was used to irrigate 100 acres, which was considered by some of the shareholders to be too great an acreage for the well. Later, when less new land is under irrigation, the supply may be found sufficient for 100 acres, if not more.

Well No. 18 is believed by Mr. Allwardt to have a discharge sufficient for the irrigation of 100 acres.

The Deeringhoff well (No. 19) watered 42 acres the first year, and is expected to supply 60 acres later. The other well on the same section (No. 21) has only a small flow, which is used on about 3 acres.

Well No. 23, just completed, is reported to have a flow equal to that of No. 1, and it will therefore be an important addition. In 1900 Mr. Peck had 114 acres under irrigation from well No. 1, which will probably now be supplied from his own well. The shade trees planted on this ranch, as well as a proposed pond near the house, promise to make the place very attractive. Where attention has been given to the use of artesian water around the residences as well as in the fields and orchards, the returns have been very gratifying, and the contrast between such ranches and the surrounding sagebrush areas is great.

It is estimated that the score or more of wells now flowing in Moxee

Valley have an aggregate discharge sufficient to irrigate about 1,600 acres. Doubtless less wasteful methods of irrigation would enable a still greater acreage to be cultivated in this arid valley without any increase in the flow of the wells.

Well No. 24, on the Wilson ranch, in Wide Hollow, has a discharge sufficient for the irrigation of 50 acres. The water is used, with that from a ditch, to irrigate 80 acres, but the well is reported to have done most of the work after July 1, the flow in the ditch being very small.

SOURCE OF THE ARTESIAN WATER.

The discussion of the source of the artesian water becomes of interest, since it may throw light upon the permanence of the supply. The underground waters of an arid region, like the surface waters, are not indigenous, but come from a distance. Commonly their source is found along the edges of the artesian basin, which may be hundreds of miles distant. There, the outcrop of the water-carrying beds forms a catchment area where the surface waters enter the underground circulation.

PRECIPITATION.

Since the Atanum-Moxee Basin is comparatively limited in extent, it follows that it must in great part fall within the region characterized by an arid climate. Especially is this true of the eastern part of the basin, where the lower beds of the Ellensburg formation outcrop along the ridges which border Moxee Valley. There the rainfall is very scanty, the annual precipitation being even less than that given on page 13. Much of the rain comes in the form of heavy showers or cloud-bursts, which find the baked soil wholly unfitted to receive the moisture, so that the proportion of run-off is at its maximum. The contribution to the artesian basin in this portion of the catchment area, therefore, is small, and were it the only supply the artesian wells of Moxee Valley could not be expected to maintain their flow for any length of time.

At the western end of the basin the conditions are somewhat more promising. The Ellensburg sandstones extend up on the flanks of the higher ridges, which are favored with greater precipitation, as is shown by the groves of large pine trees which cover them. There the snowfall is much heavier, and as the winter's accumulation melts the conditions are much more favorable for the reception of the water by the soil. Exact figures can not be obtained upon which to base even an approximate estimate of the water delivered in this way to the artesian basin. The occurrence of surface springs along these ridges shows that even the supply of ground water is sufficient to persist through the summer. It is probable that the immediate loss by run-off is not excessive in this part of the catchment area, so that the contribution to the underground supply is an important one.

STREAM CONTRIBUTION.

Another source for the underground waters may be found in the leakage from streams crossing the outcrop of the water-carrying beds. Several seasonal streams flow down the sides of the western part of the Atanum-Moxee Valley, but these are small, and their contribution may well be included under that mentioned in the preceding paragraph. Atanum Creek, however, drains a large area to the west, and in the early part of the year it is an important stream. It enters the synclinal basin at a point where the strata have gentle dips and where the sandstone at the base of the Ellensburg is open and porous. At the points where the stream crosses these upturned beds the water might seep downward into the artesian basin. Similar seepage is shown where ditches have been dug in both the surficial alluvium and in the Ellensburg sandstone. The green vegetation along the lower sides of such ditches testifies to the presence of water which has escaped through the soil and the sandstone. The fact of the seepage from Atanum Creek, however, is conclusively proved by other evidence. The stream measurements made by Mr. Babb, and quoted on page 33 of this report, have an important bearing on this question when studied in connection with the geologic relations along Atanum Creek. As will be seen by reference to the geologic map, Pl. II, the two forks of Atanum Creek enter the sandstone area above Tampico, but the stream again encounters the basalt below that place. The first measurement of the north fork of the creek was made above the point where the stream crosses the base of the sandstone, and this volume is seen to exceed, by 10 second-feet, the total volume of both forks measured below their junction and within the sandstone area. The loss by seepage is partly returned when the stream again flows upon the basalt basement, as is shown by measurement No. 9 of the table on page 33. This gain doubtless represents the return of a part of the underflow of the stream to the surface. Additional measurements farther down show a loss of 3.8 second-feet after the sandstone again becomes the floor of the valley. Further loss is shown by measurements made along the lower course of the creek, but those mentioned are of importance as showing seepage into the sandstone.

This contribution of several second-feet of water is an important one, and since these measurements were made late in July they represent a minimum of flow and probably also of seepage. At time of flood the amount flowing into the artesian basin from this source would be even greater. Taking into account the aggregate discharge of the wells of the basin, which is about 12 second-feet, the part played by seepage can at once be seen.

LEAKAGE FROM A LOWER BASIN.

In his reconnaissance of this area Professor Russell noted the scanty rainfall and concluded that the annual precipitation on the outcrops

of the water-bearing beds on the ridges adjacent to Moxee Valley was wholly inadequate to supply the wells.[1] The extension of the Ellensburg formation westward as far as shown on the map, Pl. II, was not then known, and this addition to the catchment area was therefore not taken into account. This supposed absence of any adequate surface supply and the high temperature of the artesian water were cited in support of the hypothesis that the Moxee artesian basin "is supplied from below by water rising through fissures or from the leakage upward of a lower artesian basin."[2] Further support of this hypothesis was believed by Professor Russell to be found in a fault possibly extending across the Atanum-Moxee Valley from Selah Gap to Union Gap. The evidence of fissure springs along a fault scarp in Selah Valley was also cited.

In the consideration of this hypothesis it may be well to note that further study of this area fails to show any north-south fault across the basin. As previously stated, this region is one of regular folds, with no important faults. The springs in Selah Valley near the old Ellensburg road may be termed fissure springs, but the cracks through which the water reaches the surface probably do not extend to any great depth, as the water is not warm, but is cold and very palatable. This is quite generally true of the water of springs along the lower slopes of the basalt ridges. The Clerf Spring, east of Ellensburg, described on page 45, is perhaps the most important fissure spring known in the Yakima Basin, and should be considered in this connection. Here is a large flow upward through fissures in the basalt, but the temperature of the water is considerably less than that of the artesian water in Moxee Valley. This spring proves the presence of water in the basalt at this point, and a similar source is possible for the artesian water of the Moxee wells. Evidence bearing upon this hypothesis must be indirect, however, since there are no traces of any fissures in the Moxee Basin extending upward from the basalt into the Ellensburg formation. Faulting of the nature to produce such fissures has not been detected in the basin.

The possibility of a lower artesian basin deserves a word in connection with this discussion. The Eocene sandstones which underlie the Yakima basalt farther west are of a nature to be good water carriers. They outcrop in elevated portions of the Cascade Range, where the annual precipitation is considerable, and may extend downward beneath the basalt of the North Yakima region. In that event they would contain large quantities of artesian water. The depth at which these sandstones are buried beneath the basalt, however, is such as utterly to preclude drilling wells to tap their supply of water. Furthermore, the folding to which these rocks were subjected before the basalt covered them makes the existence of a true artesian basin beneath the basalt quite problematical. Thus it is again found impos-

[1] Bull. U. S. Geol. Survey No. 108, p. 58. [2] Op. cit., p. 59.

sible to test direct the hypothesis of leakage upward from a lower basin. The facts which would bear upon this are beyond the zone in which geologic observation is possible.

TEMPERATURE DATA.

The temperature of the artesian water varies considerably in the different wells of the basin. As will be seen in the table on page 49, the range in temperatures is about 14 degrees. Doubtless there are several factors that enter into this variation. Among those which directly affect the temperature of the artesian water freely flowing from a well, the principal one is the depth of its source. The excess of the water's temperature above the mean annual atmospheric temperature, which is approximately 50 degrees in Moxee Valley, is generally considered more or less directly proportionate to the depth of the water horizon. Unfortunately, in the present case, the problem is not simple, since most of the wells are supplied with water from flows at several horizons. In such wells the discharge is mixed water from the several depths, and its temperature is consequently a resultant of the mixture.

Three of the wells tap the upper flow only, and these furnish data from which the rate of increase in temperature can be calculated. In three other wells (19, 18, and 22 of the following table) the upper flows are cased off and the lowest flow only is used. The following table shows the gradient or rate of increase for these wells, expressed in feet for 1 degree:

Table showing relation of temperature to depth in wells in Atanum-Moxee Basin.

No. of well.	Depth of flow.	Temperature.	Gradient.
	Feet.	*Deg. F.*	*Feet.*
7	515	70.7	24.8
4	637	72.2	28.7
10	835	73.2	36.0
19	625	73.2	26.9
18	752	72.2	33.8
22	820	72.7	36.1

It is at once noticed that these wells have abnormally warm water, a fact which is brought out by the rates of increase or gradients shown in the table. In other regions the usual rate of increase is 1 degree in 50 feet, so that the normal temperature for water from a depth of 500 feet in a region where the mean annual temperature is 50 degrees would be 60 degrees. It will be seen that all of the Moxee wells show a much higher rate of increase. For example: Well No. 7 has water about 10 degrees warmer than would be expected, considering the depth, which is only 515 feet. In the second place, it will be noted that the thermometric gradient is steeper in the shallow wells.

Before attempting to account for the abnormal temperature of the water, or to explain the rather exceptional variation in gradients, attention should be given to several factors which might be thought to influence the recorded temperatures. Observations of well temperatures are usually scattered over large areas, so that some differences are to be expected, but in the present case the area in which these six wells are located is limited, being not more than 1½ miles in longest diameter. Neither is the difference in elevation great, being only about 120 feet, and if the position of the water horizons be expressed in elevations above sea level the variation in gradient is not materially affected. Again, while overflowing wells undoubtedly afford the best measure of underground temperatures, it may be thought that there is considerable loss of heat in the passage of the water to the surface, so that the deeper wells might show a lower thermometric gradient. The wells here considered were all flowing freely at the time of observation, with the exception of No. 10, which, however, shows a gradient slightly steeper than No. 22, which is not quite so deep. This factor of loss of heat in the passage of the water upward in the well tube can therefore apparently be disregarded. If it were at all important, it would show underground water temperatures even more abnormal than is expressed in the foregoing table.

Temperature data obtained in artesian wells may be assumed to indicate underground temperatures, and the records from wells in different countries have been used generally by geologists and physicists in determining the normal rate of increase of temperature as the earth's crust is penetrated. It does not seem plain, however, that the water temperatures given in the foregoing table necessarily represent the earth temperatures at the levels where the wells tap the water-bearing beds. The water from these wells possesses a relatively high temperature, which may be regarded as having its origin not in the immediate source but in the greater depth from which the water is derived. The high temperature, therefore, may be said not to be indigenous but transferred. This theory involves considerable movement of the underground water, in order that the progress upward may be rapid enough to prevent loss of heat to an extent sufficient to bring the temperature of the water down to the normal temperature for the depth at which the flow is encountered. This upward transfer of heated waters must of course cause a temperature change in the inclosing rock, except where this is impervious, and therefore possesses a relatively low degree of conductivity.

This hypothesis not only accounts for the high temperature, but may also serve to explain the variation in gradient. In their progress upward (a movement taking place for the most part along the beds, and thus involving a horizontal element much greater than the vertical) the waters lose a portion of their heat, as is shown by the fact that in most cases the deeper wells discharge the warmer water.

According to the foregoing table, this loss of heat varies from 1 degree in about 100 feet to only one-half degree in 173 feet, and being entirely out of proportion with the usual rate of decrease in earth temperatures, it follows that the wells which tap the flow near the surface, and relatively higher, must show a steeper thermometric gradient than the deeper wells.

Since the lateral element is so important in the underground movement of artesian water, attention must be given to the relative position of the wells, especially with regard to the form of the basin and its probable influence upon the waters moving within the beds of sandstone. Wells Nos. 18 and 19 furnish an exception to the statement that the deeper wells discharge the warmer water. In this case, well No. 18, although tapping the water horizon 127 feet deeper beneath the surface than well No. 19, or about 100 feet lower referred to sea level, discharges water 1 degree colder than the latter well. An explanation of this may be found in the structure of the basin. As shown in fig. 7, page 48, the syncline is sharply compressed on the south side, and, as has already been stated, it is probable that the sandstones may have had their texture affected by this compression, especially their porosity. Well No. 18 is near the south side of the basin, and thus possibly within the area affected. On this supposition there is a less free movement of the underground waters in their flow toward this part of the basin, and therefore they suffer a greater loss of original heat. This hypothesis is supported by the fact that wells Nos. 5 and 9, in this part of the area, while supplied by several flows, and therefore not available for direct comparison, show the lowest gradients of any wells in the district; that is to say, they discharge cooler waters compared with wells not so deep and situated a mile or more farther north in the same basin. The comparison of these wells, supplied with what may be termed mixed waters, is not tabulated, for the element of depth becomes too complicated, owing to the several flows contributing to the discharge. It may be stated, however, that here also the general rule is that the shallower the well the steeper the gradient or rate of increase of temperature.

This discussion of the temperature data has its practical bearing on the subject of the direction of movement of the underground water and the origin of the supply. Regarding direction of flow, the evidence points to a movement along the trough of the syncline from the west, and since the dip or pitch of the fold is here to the west the movement is upward. The source of this water, then, is west of the well district in Moxee Valley. This accords with the statements made on page 13, regarding the greater precipitation in the western part of the region. Again, if the fissure hypothesis is assumed to be correct, the probable position of the fissures, as stated by Professor Russell, is in the vicinity of Yakima River, or west of these wells.

The abnormally high temperature of the water in all of these wells, together with the variation in gradient, is therefore assumed to indi-

cate upward movement; and the question remains, What is the depth at which the original temperature is acquired? It is possible that the lowest point in the syncline is deep enough to give temperatures similar to those recorded, even with a more nearly normal gradient. This, however, would not allow for any loss of heat as the water moved upward along the bottom of the basin. Furthermore, the temperature of the water from the Wilson well, in the western part of the basin, is 80 degrees, which would indicate a gradient of 1 degree in 35 feet, provided the discharge was all from the lowest flow; but being from three flows, the true gradient is somewhat steeper. This well being west of the lowest part of the basin and nearer the surface intake previously suggested, its waters are not heated by having reached any lower depth, unless fissures supply the basin. The whole question thus resolves itself into an inquiry whether the excess of temperature is due to the artesian water having its origin in fissures extending down into the basalt basement, or to a general and regional high temperature for the whole floor of the basin.

The thickness of the Yakima basalt under the Atanum-Moxee Basin is not less than 2,500 feet, and is probably much greater. So far as known, this formation includes no porous beds extensive enough to form a water horizon. Fissures extending through this mass of rock to any water-bearing beds beneath would be supplied with water of a much higher temperature than any found in these wells. Even with excessive loss of heat, the water from such a source would be hot rather than warm. The alternative hypothesis of a regional high temperature appears more plausible. This great thickness of basalt which underlies the sandstone was poured forth in Miocene time, or comparatively late, as floods of molten rock. While in the millions of years since its eruption it doubtless has lost practically all of its original heat, yet it seems probable that the cooling of the earth's crust must have been retarded over the large areas covered by these great Miocene basalt flows, especially in view of later volcanic activity, as evidenced by the Pleistocene andesitic eruption. This would result in higher earth temperatures in this region, so that the normal gradients could not be expected. Thus, since the Wilson well discharges water from three flows, the lowest of which is at a depth of 1,050 feet, the true gradient must be steeper than 1 degree increase in 35 feet.

In his study of the Dakota artesian basin, Mr. N. H. Darton[1] discovered rather exceptional thermal conditions for which no satisfactory explanation has been found. The occurrence of steep thermometric gradients over large areas may indicate here also a conservation of earth heat through the thick mantle of Mesozoic strata. Near Boise, Idaho, the conditions are more like those of the Yakima region. There the Payette sandstone is of the same age as the Ellensburg formation and, like it, contains the water-bearing beds. Hot springs issue from that sandstone, and wells sunk near the city found, at a

[1] Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. IV.

depth of about 400 feet, a supply of artesian water which has a temperature of 170 degrees. As shown by Mr. Waldemar Lindgren,[1] this hot water is apparently derived from the vicinity of volcanic vents, where in Pliocene time basaltic lava broke through the Payette sandstone.

PERMANENCE OF SUPPLY.

The practical question which comes both to those who have wells and those who are considering the advisability of drilling for water relates to the permanence of the artesian supply. The preceding section may have answered this question in part, but a few additional observations may pertinently be made.

DECREASE OF PRESSURE.

The perceptible decrease in the pressure of some of the older wells has been thought by some residents of the district to indicate an early failure of all of the wells. In most cases it will be noted that the wells first put down were located on higher ground than most of the wells at present flowing. In many of these early wells the original pressure was low, so that even a slight reduction changed them from flowing to nonflowing wells.

Several features may be cited as contributing to this decrease in pressure. When the first wells were put down the water in this basin undoubtedly was under considerable pressure, which would naturally be lessened as the stored supply of water was drawn upon. Few of the earlier wells were cased, and the possibility exists that caving and partial clogging of the wells have caused the lowering of the pressure. Lack of casing has also doubtless contributed to leakage at horizons where a difference in pressures allowed the water to escape. With even the best well construction the decrease in pressure would continue until the total discharge of the wells of the area equaled the amount of water received by the basin. The indications, judging from the testimony of the well owners, are that this state of equilibrium has been reached.

INCREASE IN NUMBER OF WELLS.

Each year new wells are being drilled in Moxee Valley, and it is probable that the success of the Wilson well will cause other wells to be put down in Wide Hollow, where water is needed. In the Moxee area, it is doubtful whether, under present conditions, the increase of wells will result in any increase in the total discharge, if the supposition be correct that the discharge now equals the supply. New wells will mean, therefore, only a further division of the water supply. In certain cases this will be advantageous, if it enables the water for irrigation to be distributed more economically. But as further demands are made upon the underground supply of water, the time must come when it will be a survival of the fittest, since the lowest

[1] Geologic Atlas U. S., folio 45, Boise, Idaho.

wells, especially those which are situated where the underground movement of water is least restricted, will continue to flow even after the pressure is lowered to a point where the higher wells can not be supplied. If the foregoing suppositions regarding the movement of the artesian water in this basin are correct, the wells that would continue to flow would be those having the warmest water.

The underground supply of water must not be considered unlimited, any more than the surface supply. The artesian basin should be regarded simply as a reservoir in which water is collected and stored, and not only should wasteful use of it be avoided, but the fact that it is stored should rather prompt economy in its use. In view of the possibility of exhausting the artesian resources of the district, more attention should be given to preventing waste of the water.

PRECAUTIONS TO BE OBSERVED.

Unfortunately, some wells are so constructed that the discharge can not be controlled, and waste must continue both at the surface and below; hence it is of prime importance that attention be given to correct construction of the wells. The following practical hints, quoted from a report of Prof. J. E. Todd,[1] will serve to call attention to geologic conditions which must be kept in mind if a well is to be a permanent success:

(1) Since the pressure in the upper flows is less than in the lower by many pounds to the inch, it is very important that the communication between the lower flows and the higher should be entirely cut off, otherwise the full pressure from the lower stratum will not be observed at the mouth of the well, but will expend itself by leaking into the strata below the surface. The desire of the well digger to keep his pipe loose may tempt him to leave the bore too large—hence the danger we speak of.

(2) It is very desirable that the larger pipe lining the bore be firmly fixed in the hard stratum above the water-bearing rock. This may be done in most localities, as a compact stone is found just above the porous sands which bring the water. Much depends upon this, for if a pipe be left loose and the opening in the rock left incompletely stopped water is likely to escape around the pipe, and if not checked may eventually destroy the well.

(3) A well should be sunk as rapidly as consistent with good work, especially after water has been reached, otherwise the great pressure of the water may cause it to erode an irregular opening and prevent the accomplishment of the two points already given.

The leakage from lower flows into upper porous beds apparently has taken place in Moxee Valley. A spring which within a few years has broken out near the center of sec. 9, T. 12, R. 20, very probably is supplied by leakage from some of the wells in sections 10 or 3 which have stopped flowing. This loss may be sufficient to make a well valueless, and it is an argument for properly casing a well, an additional expense at the time, but an outlay that will insure the whole investment.

Most important of all is the economical use of water. In 1900 few

[1] Water-Supply and Irrigation Paper U. S. Geol. Survey No. 34, p. 30.

wells in the Moxee district were supplied with valves, and therefore the full discharge continues day and night, summer and winter, regardless of whether or not the water is needed. This flow of the wells in the winter is a wholly unnecessary drain upon the underground supply, and is doubly to be deprecated since the presence of the water on the land during that season of the year must be injurious. Entirely shutting off the discharge might introduce the danger of clogging the wells with sand, but they could be fitted with valves so that most of the water could be shut off. In addition to shutting off the supply, the valve can, by partial closing, be used to increase the pressure and thus force water through a smaller pipe into the house.

Closing the wells during the winter months, except for very small flows sufficient for ordinary use about the house and for the stock, would result in the accumulation of water, which would be available the following summer, when most needed, and the pressure for the whole basin would undoubtedly be increased, as shown by a fact cited by Mr. Frank Leverett.[1] Wells in the vicinity of the Chicago stock yards are reported to flow for only a brief period each week, after the Sunday intermission from pumping. In that case a few hours' accumulation proves sufficient to raise the pressure, and it is plain that several months' accumulation would make considerable difference in the pressure in the Moxee wells.

This matter of economy in the use of the artesian water should be taken up by those most interested. Legal enactment would not accomplish much more than a local agreement. The result desired is to insure a permanent supply of water for the irrigation of the valley, and every property owner in the district should be ready to subscribe to articles of agreement. This arrangement appears practicable, since those interested live within a radius of a few miles and constitute practically a single community.[2]

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[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 787.

[2] Since the completion of this manuscript it has been learned that the conservation of the underground water supply of the Moxee Basin has been provided fo by legislative enactment. and that the following bill is now on the statute books of the State Washington. Such a law as this is unique in its form and application. It undoubtedly me with the hearty approv of those most interested, and should be rigidly enforced.

CHAPTER CXXI.

(H. B. No. 203.)

RELATING TO ARTESIAN WELLS.

AN ACT in relation to artesian wells and regulating the flow of water therefrom, and providing a penalty for the violation thereof.

Be it enacted by the legislature of the State of Washington:

SECTION 1. It shall be unlawful for any person, firm, corporation, or company having possession or control of any artesian wells within the State, whet as contractor, owner, lessee agent, or manager, to allow or permit water to flow or escape rom such well between the first day of October in any year and the first day of April next ens g: *Provided*, That this act shall only apply to sections and communities wherein the use of r for the purpose of irrigation is unnecessary or customary, and providing further, that g herein contained shall prevent or prohibit the use of water from any such well between said first day of October and the

The future of Yakima County promises to be such that every foot of water available for irrigation can and will be utilized. A few hours' ride over any part of the county where new land is being put under cultivation is sufficient to convince one of the great agricultural possibilities of the region, but without proper conservation of the water resources these possibilities can not be made to contribute to its future wealth.

---

first day of April next ensuing for household, stock, and domestic purposes only, water for said last-named purposes to be taken from such wells through a one-half inch stop and waste cock to be inserted in the piping of such well for that purpose.

SEC. 2. It shall be the duty of every person, firm, corporation, or company having possession or control of any artesian well, as provided in section 1 of this act, to securely cap the same over on or before the first day of October in each and every year in such manner as to prevent the flow or escape of water therefrom, and to keep the same securely capped and prevent the flow or escape of water therefrom until the first day of April next ensuing: *Provided, however*, it shall and may be lawful for any such person, firm, corporation, or company to insert a one-half inch stop and waste cock in the piping of such well, and to take and use water therefrom through such stop and waste cock at any time for household, stock, or domestic purposes, but not otherwise.

SEC. 3. Any person, whether as owner, lessee, agent, or manager, having possession or control of any such well, violating the provisions of this act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined in any sum not exceeding two hundred dollars for each and every such offense, and the further sum of two hundred dollars for each ten days during which such violation shall continue.

SEC. 4. Whenever any person, firm, corporation, or company in possession or control of an artesian well shall fail to comply with the provisions of this act, any person, firm, corporation, or company lawfully in the possession of land situate adjacent to or in the vicinity or neighborhood of such well and within five miles thereof may enter upon the land upon which such well is situate, and take possession of such well from which water is allowed to flow or escape in violation of the provisions of section 1 of this act, and cap such well and shut in and secure the flow or escape of water therefrom, and the necessary expenses incurred in so doing shall constitute a lien upon said well, and a sufficient quantity of land surrounding the same for the convenient use and operation thereof, which lien may be foreclosed in a civil action in any court of competent jurisdiction, and the court in any such case shall allow the plaintiff a reasonable attorney's fee to be taxed as a part of the cost. This shall be in addition to the penalty provided for in section 3 of this act.

Passed the House March 7, 1901.

Passed the Senate March 14, 1901.

Approved by the Governor March 16, 1901.

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

METHODS

OF

STREAM MEASUREMENT

WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., July 10, 1901.

SIR: I have the honor to transmit herewith a manuscript describing the methods of stream measurement in use by the Division of Hydrography, and request that it be published in the series of Water-Supply and Irrigation Papers. This material has been compiled from various reports and letters of instruction, and is intended to embody not only a description of the operations but in some cases minute directions which may assist the hydrographers and serve to increase the accuracy of results. It is designed not only to assist and guide the hydrographers employed by the Survey or working in cooperation with it, but also to exhibit as nearly as possible the degree of accuracy of the operations and of the computations of results. It is hoped that hydraulic engineers and others who may be engaged in similar lines of investigation will adopt these methods or so modify their own operations that the results will be comparable with those obtained by this Survey.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

METHODS OF STREAM MEASUREMENT.

INTRODUCTION.

The object of the work herein described is to obtain data bearing upon the water resources of the United States. In undertaking with limited funds an investigation of this character, it is obvious that a plan must be adopted which will yield useful results with moderate outlay. The United States is so vast and offers such diversity of topographic and climatic conditions that measurements of rivers in one section give data of little value concerning those of another section. It is therefore necessary to consider carefully the distribution of field work so as to obtain typical results, and at the same time not to diffuse it so widely as to destroy its effectiveness. The chief object has been to lay out the operations so that there would be obtained results of practical value and of a reasonable degree of accuracy, broadly representative of conditions prevailing throughout the United States, without expending money for the attainment of an unnecessary degree of precision. There is of course room for wide difference of opinion regarding the best way to attain this object. In the practice of the Survey localities have been selected where the results will have a local application to problems of development and at the same time will yield data which can be applied to adjacent areas under similar topographic conditions.

The operations of the branch of the Geological Survey which has to do with hydrography can be divided into three distinct classes: (1) The measurement of surface streams; (2) the survey of sites for and the estimation of capacity and cost of reservoirs; and (3) the study of the quantity and movement of underground waters. The greater part of the funds available, however, is devoted to the measurement of surface streams, for those are of first importance, regarding both the quantity of water obtainable and its industrial application.

The work of ascertaining the flow of a stream, as developed by the experience of the Division of Hydrography, extending through about thirteen years, consists of (1) observing and recording the daily height of the water, (2) measuring the quantity of flow at different heights, and (3) computing the probable flow at each height or stage of the stream.

The first step is to select a suitable locality for a gaging station. Although apparently simple, this is really a difficult task. Not only must the actual conditions be favorable—the water moving in nearly

straight lines over a solid bed and between well-defined banks—but the place must be accessible at moderate cost, and there must be living near a competent person who can be engaged to serve as observer. Usually it is impracticable to hire a man to remain at a locality to observe daily the height of the water and make occasional measurements of the volume. It therefore becomes necessary to locate the station where a person of ordinary intelligence can be employed, at from $2 to $5 a month, to observe and note the height of the stream once or twice a day, and each week send to the Survey a postal card containing a record of these facts. So that in perhaps the majority of cases the station is located not at the most desirable place for obtaining the information desired, but at the best locality where a competent observer can be procured.

When a suitable location has been found a gage is established, on which the height of the water can easily be read to tenths of a foot. The gage may be either a vertical or an inclined scale, fastened to a pier or attached to supports firmly bedded in the bank. If inclined, it is graduated, after setting, to vertical tenths of a foot, thus affording a magnified reading which is always at the shore line. Sometimes a wire gage is used, a weight being lowered from a bridge or overhanging support, and the distance noted along the horizontal scale. Whatever the device the gage should be referred to permanent bench marks and maintained without alteration.

From time to time the engineers—or hydrographers, as they are termed—visit and inspect the stations and make measurements of the volume of flow by means of a current meter or otherwise. Many forms of current meter are in use. Those preferred have an electric appliance so arranged that every revolution of the wheel causes a click or buzz in a small sounder in the hand or pocket of the hydrographer. Many automatic devices have been tried, but in the long run this form has proved the most satisfactory. In using it, the hydrographer counts and records in a notebook the number of repetitions of the sound during, usually, 50 seconds. The meter is placed in various parts of the cross section by suspending it from a boat or bridge, or, more commonly, from a car in which the hydrographer sits, which is supported by a stout steel cable extending across the stream. (See Pl. I.)

From the occasional measurements of discharge there is constructed, usually by graphic means, a table showing the volume of flow for each tenth of a foot height of the water. From this table the discharge is placed opposite the corresponding gage height for each day, thus giving the fluctuations of the stream, which may be stated in terms of maximum, minimum, and mean for the month, or be shown graphically by diagrams. If the area drained be known, these results can be expressed in units of area and volume, or in depth over the entire catchment basin. The details regarding these measurements and computations are given on the following pages.

A.

B.

CARS USED IN MEASURING VELOCITY OF STREAMS.

A, Shenandoah River near Millville, W. Va., *B*, Arkansas River at Canyon, Colo.

WEIR MEASUREMENTS.

The flow of water in open channels is controlled by a variety of conditions due to artificial as well as natural features, and no definite rule for gaging can be prescribed which will be applicable to all cases. The methods of operation must therefore be governed largely by local conditions, and should be varied as circumstances require. The accuracy of the results obtained is consequently dependent in no small degree upon the judgment exercised by the hydrographer in dealing with individual cases.

In general, measurements of the volume of flowing water in open channels may be classed under two heads: (1) By means of weirs or dams used as weirs, and (2) by determining the mean velocity and the sectional area for a given cross section. Using the first method, the discharge of the stream is computed by means of an empirical formula, which varies for different types of dams or weirs. On creeks or small rivers it is sometimes practicable to build a timber weir across the channel, causing the total flow of the stream to pass over the sharp edge of the weir crest. Various forms of these weirs are shown in Pls. II and III. By observing the head on the weir computations of the flow can be made. This is probably the most accurate method applicable to small streams. On large rivers, however, the cost of a weir is usually so great as to be prohibitive, so that if there is not a weir or dam already in the stream it is necessary to resort to measurements by floats or current meters, as described further on.

On many rivers of moderate size the conditions are unfavorable for successfully applying either of these methods. For instance, on streams used for manufacturing purposes dams occur at frequent intervals, interrupting the regular flow and in many cases holding back the night flow for use during the following day, so that the discharge during the night may be either nothing or a very small percentage of the day flow. Then, too, the shutting down of the mill wheels for an hour at noon may have a pronounced effect upon the results of float or meter measurements made below the mill. Unfortunately these variations are not always apparent to the hydrographer, and surprise and annoyance are caused by finding that the river height differs by several tenths from the gage as read by the regular observer possibly an hour or two before the hydrographer arrived at the station.

Frequently it is almost impossible to find a section upon a stream used for industrial purposes where the flow is not interrupted by the backwater from dams below. If a station is selected at the time of high water this backing up of the river may not be apparent to the hydrographer, but at the low-water season he may find that the river at the station is merely a placid pond, apparently without current, making measurements impracticable. Examples are Blackstone

River in Massachusetts and Rhode Island and the Sandusky in Ohio. If the fall of a stream is sufficiently rapid a section for meter measurements may be found just below one of the milldams, measurements at such points not being affected by the backwater. They are, however, subject to all of the changes due to gate openings at the mills above.

MILLDAMS AS WEIRS.

Under the conditions described better results can undoubtedly be obtained if there exists upon the stream a good dam which can be used as a weir. It should have a level, even crest and a constant cross section, with sufficient pondage to reduce the velocity of approach, and it should be free from leakage. Masonry dams are better for this purpose, for they are more likely to be tight and to have an even crest. Timber dams although level when first constructed are likely to settle at various points across the stream, thus producing an uneven crest elevation. There are, however, many good timber dams practically free from leakage and with crests sufficiently uniform for accurate work. Pl. IV shows two dams suitable for use, and Pl. V shows two not suitable for use.

Having selected a dam as the proper site for a station, a careful survey must be made of the crest line and of the upper and lower slopes, so that it can be compared with other dams or with experimental sections for which the coefficients of flow are known. The experiments of James B. Francis, of Fteley and Stearns, and of John R. Freeman, George W. Rafter, and others at Cornell University have given coefficients upon many sections of various forms. It is probable that the dam selected for the station will not be exactly like any of the experimental forms, but it will resemble some of them so closely that coefficients can be selected for the computations.

When the mill gates are open a part of the flow of the stream is diverted from the river through the millrace, the gates, and the tailrace. The amount of the diversion must of course be measured and added to the quantity flowing over the dam in order to determine the total discharge of the stream. In many factories the quantity flowing through the wheels varies from day to day, and also during different hours of the day, so that careful records must be kept of the gate openings in order that proper allowance may be made for these variations. The size and the make of the water wheels must be ascertained and the wheels be used as water meters for the determination of the flow through them. Many of the modern wheels have been carefully rated. Where such ratings have not been made, usually records of wheels of the same type, though possibly of different makes, can be found and the records be compared. Water wheels as meters give fairly accurate records of the discharge.

It will be seen that this method of measuring the flow of streams over dams and through the wheels is somewhat complicated by the

A.

B.

MEASURING WEIRS.

A Los Angeles River, Cal.; *B*, Cippoletti weir on Little Cottonwood Creek, Utah.

number of records that are taken, which include the height of the water on the crest of the dam, the number and size of the gate openings, the time of starting and stopping the wheels, and all changes of gates; yet in many cases the results obtained will be more accurate than those derived from meter measurements made under unfavorable conditions. A sample of one of the record sheets is given herewith:

Sample of record blank used by United States Geological Survey for recording the flow of streams over dams and through water wheels.

U. S. GEOLOGICAL SURVEY.

Gaging record kept on Schoharie Creek at the Schoharie Falls Dam of Empire State Power Co., Mill Point, N. Y.

For the month ——, 190—. —— ——, *Recorder.*

Day.	TWO PAIR 40-inch LEFFEL, SAMSON TURBINES. DAY RUN. Pair No. 1.		Pair No. 2.		NIGHT RUN. Pair No. 1.		Pair No. 2.		Crest Gage Above Dam, feet.		Canal Overflow Gage and Waste Gates, feet.		Head Race Gage in Forebay, feet.	Tail-race Gage, feet.
	Number hours run.	Average Gate Opening.	Number hours run.	Average Gate Opening.	Number hours run.	Average Gate Opening.	Number hours run.	Average Gate Opening.	a. m.	p. m.	a. m.	p. m.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1														
2														
3														
4														
5														

All gage readings are in feet and decimals. Write each reading plainly in proper column. Put notes as to leakage, ice on dam, waste gate openings, etc., on back of sheet.

[The blank has spaces for 31 days; the above is simply a sample.]

When flashboards are used records must be kept of their height and of the time of placing them, so that a different formula can be used for flow over the flashboards than for that over the broad-crested weir. It is customary to use Francis's formula for sharp-crested weir for computing the flow over the flashboards. Some of the difficulties encountered in measuring the flow of streams by using a dam as a weir are described in the Twenty-first Annual Report, Part IV, page 31.

VELOCITY MEASUREMENTS.

The second method, and the one commonly used for determining the flow of streams, is that in which the area of cross section is multiplied by the velocity per second of the water passing through the section. The units commonly employed are those expressing the area of the cross section in square feet and the mean velocity in that cross section in feet per second. The velocity can be measured by either of the following methods: (1) By means of floats; (2) by means of current meter or other mechanical device.

FLOATS.

This method is employed only when circumstances do not permit the hydrographer to use a current meter. If possible the site should be on a straight reach having a fairly uniform cross section. The flow of the water should be regular, without sudden rapids or stretches of still water, and should exhibit no tendencies to form eddies or cross currents caused by irregularities in the channel or resulting from the effect of a sharp bend above the reach. The course of the floats should have a length of from 100 to 300 feet, and the areas of the cross sections at the upper and lower ends of this course should be carefully determined by soundings. In the case of courses more than 100 feet in length it is desirable that additional cross sections, spaced at equal intervals apart, should be sounded. As a preliminary step a base line should be laid off, by tape, on the bank, as nearly as possible parallel with the stream, and points should be marked opposite the cross sections to be measured. If the stream is not too wide the soundings in a cross section can be taken most conveniently along a tagged rope stretched across the channel at right angles to the base. If the depth does not exceed 4 feet this can be done by wading, the depth being read on a rod graduated to feet and tenths. Should the depth of the channel or the temperature of the water make wading impossible, a boat should be used. On large rivers, where a tag rope can not be employed, the boat from which the soundings are to be made should be located by simple triangulation or stadia. Soundings should be read to tenths of a foot and be taken, preferably, at equal distances apart. In deep rivers a tagged rope or chain with lead weight can be substituted for the rod.

A MEASURING WEIR IN GENESEE RIVER NEAR PORTAGE, N. Y.

B. GAGING STATION ON CLEAR CREEK, WYO.

In reconnaisance work, in which the equipment is as a rule limited by transportation facilities, surface floats consisting of chips will be found most convenient. The use of rod floats, though giving more directly the mean velocity, has many disadvantages and should not be attempted unless time and opportunity permit of obtaining floats of the required lengths. In the simplest case but one man is needed to make the observations. The surface floats should be thrown into the stream a considerable distance above the first cross section. The hydrographer should attempt to start the floats, successively, at different distances from the shore, in order to determine the velocity in different parts of the channel. The time of the passage of each float between the upper and lower cross section should be noted, preferably by a stop watch, and also the position of each float with respect to the tags on the ropes. This will enable the hydrographer to determine whether or not he succeeds in covering the different parts of the stream, and it will serve as an aid in the computation. The observations should be continued until all parts of the stream have been covered.

On wide rivers range poles should be established on opposite shores to mark the upper and lower cross sections. The location of each float as it crosses these imaginary lines can readily be recorded by triangulation. A light traverse plane table will be found especially useful in obtaining a graphic record.

In case rod or tube floats are employed care should be taken to select their lengths to suit the depths of the channel. They should be weighted and adjusted as to depth of immersion so as to move in a vertical position, the bottom clearing the bed of the stream sufficiently to avoid contact with irregularities and the top projecting far enough above the water to be plainly visible. The velocity indicated by a rod or tube float is slightly in excess of the mean velocity of the path traversed, the error being mainly traceable to the distance between the bottom of the float and the bed of the river, the slowest velocities not being taken into account. As a rule the error is small enough to be negligible in this class of work, and the velocities so obtained may be regarded as representing mean velocities.

The method of gaging streams by the aid of floats can be simplified or elaborated according to the nature of the case and the time and facilities at the command of the hydrographer.

In making the computation the area of the cross section is obtained by averaging the areas of all the cross sections measured, provided they are taken at equal distances apart. Care should be exercised to exclude from the computation all areas of still water along the shores. The float measurements should be grouped and reduced to form a set of velocities about equally distributed across the channel, and the mean of this set be taken to represent the mean surface

velocity of the stream. The mean velocity for the entire stream may then be assumed to be 0.8 of the former. For the average stream this relation is close enough for all practical purposes, provided the motion of the floats is not affected by wind. For that reason floats should be selected which while being easily discernible do not project unnecessarily above the water.

While this method of gaging does not yield accurate results, it is useful in reconnaissance work. Aside from the uncertainties entering into the observations, the assumptions on which the methods of observation and computation are based introduce additional sources of error, and the method should not be used at regular gaging stations.

CURRENT METERS.

The mean velocity in a vertical can be determined with the current meter in three ways: (1) By making point measurements at a depth corresponding to the approximate position of the thread of mean velocity; (2) by deducing the mean velocity from observations made at other points in the same vertical; and (3) by the integration method.

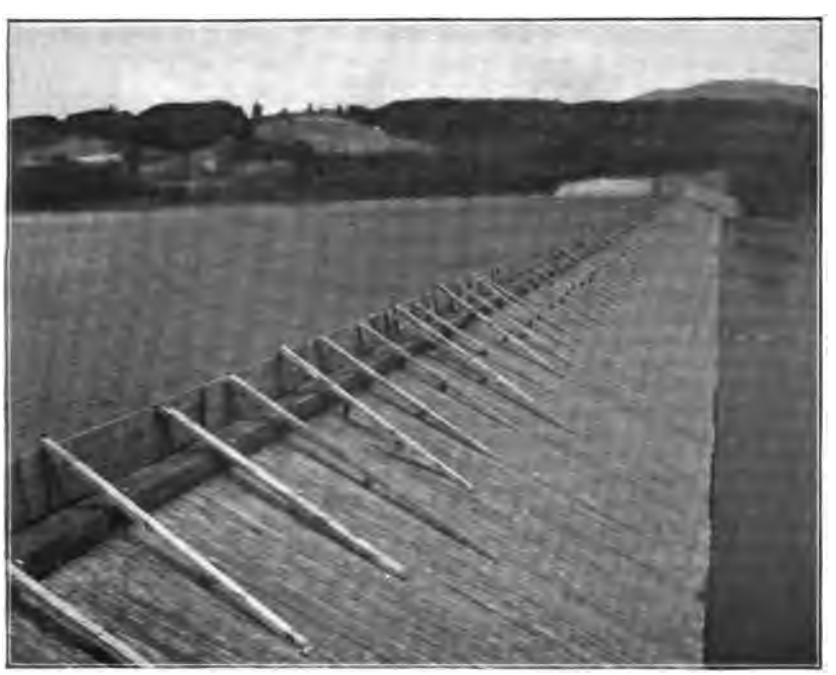
UNIT MEASUREMENTS.

Studies of the vertical velocity curve made on the Mississippi by Humphreys and Abbot, on the Connecticut by T. G. Ellis, on the Merrimac flume by Wheeler and Lynch, on the Potomac by C. C. Babb, and recent experiments by others, notably those at Cornell University by E. C. Murphy, indicate that the position of the thread of mean velocity in a given vertical section occurs at a depth varying from six-tenths to two-thirds of the total depth of the section, measured from the surface down. The values found in the experiments mentioned were as follows:

	Depth.
C. C. Babb	0.58
Humphreys and Abbot	.63
T. G. Ellis	.64
Wheeler and Lynch	.67

The Cornell experiments indicate that measurements made at 0.6[illegible] of the depth yield results 4.7 per cent too large, the depth of mean velocity corresponding more nearly with the values obtained by Wheeler and Lynch. In this connection it should be noted that the Cornell experiments, as well as those of Wheeler and Lynch, were made in canals and flumes, the cross sections of which have a greater ratio of depth to width than those of the Mississippi, Connecticut, and Potomac rivers. That this difference in the ratio of depth to width is a factor likely to affect the position of mean velocity will be seen from the following considerations:

A.



B.

DAMS SUITABLE FOR USE IN MEASURING FLOW OF STREAMS

A, Stone dam at Holyoke, Mass., with 2 feet of water on crest; *B*, dam on Hudson River at Mechanicsville, N. Y.

It is a well-established fact that owing to the roughness of the lining of a channel, be the projections ever so minute, particles of water are continually deflected from the sides of the channel, the deflection naturally taking place in the direction of least resistance, i. e., toward the surface and center of the stream. This causes a constant upward flow along the sides of the channel, and a surface flow toward the center, with a tendency to lower the position of the thread of maximum velocity in any given vertical and in the entire stream. This depression of the maximum velocity is known to become more pronounced as the roughness of the lining increases. It also increases with the steepness of the banks and as the ratio of depth to width increases.

In the extreme case of a wide, shallow stream, where the bottom merges imperceptibly into the banks, maximum velocity occurs under normal conditions at or very near the surface of the center of the stream. On the other hand, in a deep, narrow channel, as, for instance, in a flume with vertical sides, maximum velocity occurs a considerable distance below the surface, and, as the Cornell experiments indicate, this depression may amount to as much as one-third, and even two-fifths, of the total depth.

Evidently, in such cases depression of maximum velocity must result in a lowering of the thread of mean velocity, and hydrographers in making unit measurements for mean velocity should therefore bear in mind that while observations at 0.60 depth give fair values for mean velocity in wide, shallow rivers, this ratio should be increased to 0.67 depth in the case of canals and flumes or narrow and deep natural channels.

MULTIPLE MEASUREMENTS.

The following methods are in use: (1) Observations at top and bottom; (2) observations at mid depth; (3) observations of surface velocity; and (4) observations at a series of points in a vertical.

(1) By the first method measurements are made in each vertical as near the bottom as the construction of the meter will permit, also just below the surface. The mean of the results so obtained is taken as the mean velocity. This method should never be used except in streams shallow in comparison with their width. The method assumes that the vertical velocity curve is a straight line, a condition which exists in very few streams. In all streams where the depression of maximum velocity is material the mean velocities obtained by this method are invariably too small.

(2) The second method consists of making measurements at mid depth, and taking about 95 per cent of the result to obtain the mean velocity. This method at best is unsatisfactory, as the velocity at mid depth can not be said to bear a constant relation to the mean velocity.

(3) Measurements of surface velocity are frequently the only measurements obtainable, as, for instance, in streams of great velocity during a flood stage, when it becomes impossible to lower the current meter or to maintain its position at a desired depth. In such cases the only course left is to measure surface velocity and deduce the mean velocity from it by multiplying the former by a factor. The error in this method is the assumption that surface velocity, or the velocity indicated by the current meter just below the surface, bears some direct relation to the mean velocity. From the foregoing discussion it will be apparent that the assumption is not correct, and considerable judgment should be exercised in computing the mean velocity. Where from the nature of the conditions it appears that the surface velocity practically represents the maximum velocity, a factor of 0.8 should be taken; while in case the maximum velocity occurs lower down, a factor of 0.9, and even of 1.0, should be used to obtain the mean velocity.

(4) The fourth and most accurate method is to make measurements at regular intervals in a vertical, plotting the velocities so obtained on cross-section paper, and determining the value of the mean velocity by dividing the area inclosed by the curve by the total depth.

INTEGRATION METHOD.

By moving the current meter uniformly in a vertical from the surface downward until the bottom is reached, then moving it upward, repeating the operation as often as desired, the velocities in the vertical are integrated mechanically, and the mean velocity can be computed by noting the time and the number of up and down movements made. Care should be taken that the motion is uniform and sufficiently slow to prevent the introduction of large errors into the resultant velocities, due to the up or down motion of the meter. Stearns's experiments indicate that in moving the Fteley meter at a velocity not to exceed 5 per cent of the velocity of the current no material errors are introduced. The construction of the meter should always be taken into account in considering or allowing for errors of this kind. Thus in the use of the Fteley meter a too rapid up or down motion causes a decrease in the velocity indicated, while with the Price meter, or, indeed, with any form of meter adjusted to head in the direction of the resultant velocity, the results will be too large. For both kinds of meter, however, the errors, whether negative or positive, will be largest in integrating low velocities.

Aside from the method just described, integration of the entire cross section of a stream can be made by moving the meter obliquely up and down, starting at one bank and proceeding across the stream. This method has a limited application, for in the first place the measurement must be made from a bridge or by wading, and in the second place the time of the up and down motions must be varied pro-

A

B

DAMS NOT SUITABLE FOR MEASURING FLOW OF STREAMS.

A, Rome waterworks dam on Mohawk River at Ridge Mills, N. Y.; *B*, dam on Ninemile Creek at Stittville, N. Y.

portionately to the depth, which in an irregular channel requires considerable computation. The method is employed to best advantage on flumes, where the depth is uniform and where a plank can be thrown across at any suitable point to permit the hydrographer to proceed gradually across the channel.

GAGING STATIONS.

In the selection of sites for permanent gaging stations much depends upon the judgment and discretion of the hydrographer. If possible the section selected should be in a straight portion of the channel, where the flow is regular and free from natural or artificial obstruction. Sections near bridges which contain accumulations of brush and snags in which current meters are likely to become entangled should be avoided, also proximity to dams, either above or below the station. It is important that the banks be fairly high and not likely to overflow except at unusually high stages of the river, and that the bed should exhibit no tendencies to shift or be subject to other changes produced by scouring out or filling in of sediment.

A river channel is often obstructed by piers and cofferdams, which set up cross currents and render it impossible to obtain accurate measurements in their vicinity. In such cases other points of measurement must be selected and other means of making them be employed. Where the streams are deep boats are used (Pls. VI, *A*, VII, and VIII) or cables are suspended out of reach of flood water. In some localities boats possess a certain advantage, but where they can not be hired at moderate outlay it has been deemed impracticable to purchase and keep them, for they are likely to be injured or stolen during the intervals between measurements.

It is desirable that the gage be set so that no minus readings will occur—the zero being placed say 1 foot below the lowest known stage; but information on this point obtained from the oldest inhabitants will often be found erroneous or unreliable, and a safe margin should be allowed.

Where possible two or more gages should be established at each station, being connected by level lines, so that the slope of the water surface can be read at various elevations.

It should be borne in mind by the hydrographer in the field that the object is to obtain data of the most value to the public. Work that has only local application or is limited in scope should not be undertaken. In entering upon an investigation, or in preparing a report of the results of the work, full information should be given regarding its purpose, and mention should be made of all facts which in any way affect its value. The simple statement that a certain stream was carrying at a specified time a stated amount of water is in itself important, but its value can be greatly increased by the statement of additional facts, such as, for instance, the reason for

making the measurements, the character of the drainage basin above and below the station, and the changes in the behavior of the stream which may have been produced by annual fluctuations in the run-off, by excessive temperatures, by artificial obstructions or diversions of the water, or otherwise. Facts of this character usually are well known to the hydrographer at the time he makes his report, and may appear to him too trivial to mention; but it should be remembered that the figures which he submits will be used again and again by persons who do not understand the local conditions, and for that reason may be misapplied.

The object of daily observations is to procure material for the computation of discharge. If the conditions at a station are such that the readings can not be made with a reasonable degree of accuracy, the observations should not be continued. The difficulties may arise from several causes—from the irregular, shifting character of the channel, from the impossibility to obtain reliable gage heights and soundings, or from the inability of the resident hydrographer to visit the place at proper times and seasons. It is necessary, therefore, to carefully consider from time to time the advisability of maintaining stations already established, in order that efforts may not be wasted in continuing readings of dubious value.

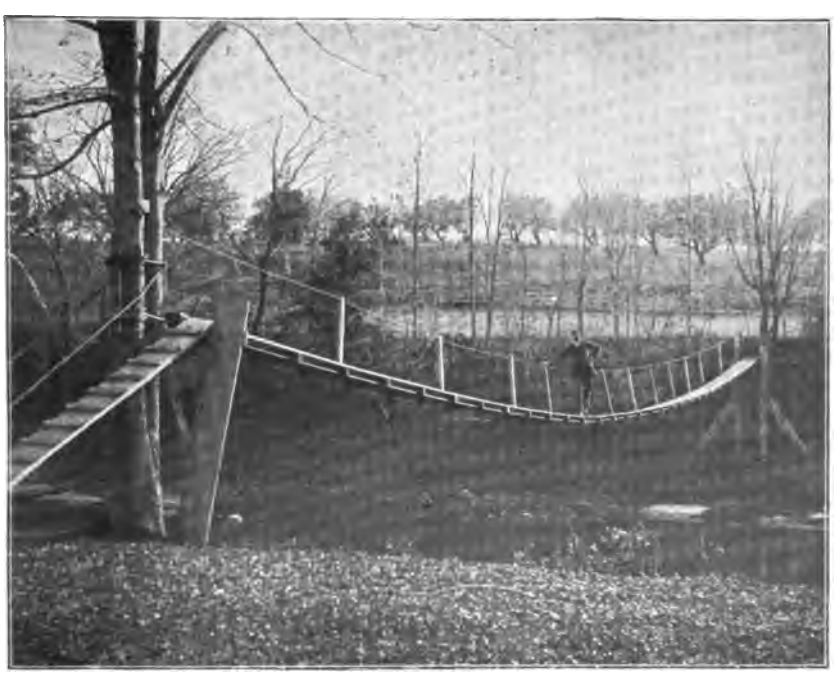
BRIDGE STATIONS.

Because of the permanency of their character, the small expense involved, and the great freedom of movement which they permit the hydrographer, bridges are preferred for gaging stations and for the making of discharge measurements. (See Pls. VI, *B*, and VII, *A*.) High trestles and railroad deck bridges should, however, be avoided, for they unnecessarily expose the hydrographer to danger. Covered bridges, unless provided with numerous windows, are not desirable, for they limit the operations. Bridges that are to be used as permanent gaging stations should be marked once for all, either on the guard timber or in some other conspicuous place, with stenciled figures, say 5 or 10 feet apart, indicating sections and points for measurement. In case a stencil is not available nails or tacks can be used to advantage.

CABLE STATIONS.

Frequently it is impossible to establish a permanent gaging station at a bridge. In that case the wire cable of a ferry can be utilized, or, if that is not available, a permanent wire cable can be swung across the river. For spans of average length a galvanized wire cable three-fourths of an inch in diameter is safe. It should be supported on each bank by means of high struts or by passing it through the crotch of a tree. The cable should be run into the ground and anchored securely to a "dead man" buried at least 3 feet below the

A. MEASURING VELOCITY OF WATER FROM FERRYBOAT, TUGALOO RIVER, NEAR FORT MADISON, S. C.



B. SUSPENSION BRIDGE FOR MAKING STREAM MEASUREMENTS, NESHAMINY CREEK, RUSH VALLEY, PA.

surface. In the portion of the cable between the strut and the "dead man" a turn-buckle should be inserted so as to permit tightening the cable when it begins to sag.

A few feet above the cable a wire, provided with tags 5 or 10 feet apart, should be stretched across the stream to serve the same purpose as the stenciled distances on the bridge already referred to. For this purpose the ordinary twisted barbed fence wire has been found very useful, as the tags can be fastened firmly so that they will not slip from side to side, and barbed wire is less likely to be stolen than the ordinary smooth wire. The best tags are made of metal 3 to 4 inches wide, deeply notched so as to indicate at a glance the distance from the initial point. (See Pls. VII, *B*, and VIII.)

A box large enough to hold two men should be constructed and suspended from the cable, by means of cast-iron pulley wheels, in such a manner that it can be run freely in either direction. (See Pls. I, IX, and X, *A*.) An iron or wooden bar lying horizontal and parallel with the cable should connect these pulleys so as to hold them apart. The cable should be high enough above the river so that there will be no danger of the box striking the water during floods.

ROD GAGES.

Well-seasoned timber should be selected for the construction of rod gages, the usual size being 5-inch by 1-inch or 6-inch by 1-inch boards, with at least one face planed. The rods should be graduated to feet and tenths, the graduations being painted in black on white ground, the even-foot marks being conspicuously indicated by painted or brass figures. The datum used is immaterial, provided the zero of the rod is covered by water at even the lowest stages, so as to obviate the use of minus readings. Care should be taken to set the rod vertically. In case the gage is at a bridge station it will generally be found possible to spike it securely to an abutment or pier, where it can easily be read from the shore and not be carried away by ice or floating débris. At cable stations the rod should be spiked to a tree standing in the water, or, if a tree is not available, it can be bolted to a ledge in the stream.

Frequently it will be found best to incline the rod, if it can not be secured in a vertical position without danger of being swept away. An inclined gage should be held in place by long stakes driven into the ground, and no graduations should be marked on it until it has been properly fastened. The slope of the rod should then be accurately determined by the aid of a surveyor's level, and the length of the graduations be computed on the basis that one division on the rod corresponding to 1 foot vertical is equal to the cosecant of the angle of inclination of the rod, in feet. It may be found more convenient to secure the gage rod in position and then graduate it by the use of an engineer's level. To put the graduations on an inclined

gage, particularly on that portion extending under water, metal strips will be found most convenient. They can be nailed on without difficulty, and are more permanent than paint.

WIRE GAGES.

Wire gages will be found useful, especially on high bridges where it is difficult to read with accuracy the water level on a vertical rod gage or where the abutments or banks are not favorable for the erection of any other form of gage. A rod gage graduated to feet and tenths in the manner already described can be utilized for this purpose, being nailed in a horizontal position along the bridge rail or guard timber. The fluctuations of the water level are noted on this gage by lowering a weight attached to a wire or chain provided with a pointer or marker which is made to run along the graduations of the rod. The position of the pointer is read on the rod when the bottom of the weight just touches the surface of the water. The movement of the weight and wire is facilitated by means of a small cast-iron pulley fastened to the side of the bridge. Wire gages can also be used in other places, as illustrated in Pl. X, *B*.

Experience has shown the necessity of frequently testing the wire gages and correcting them to the original length. Great confusion is introduced in computations unless the gages are kept within a tenth of a foot or less of the correct length. When installed the gage should be so arranged and permanent marks be so made that the length of the gage can readily be tested. The description of the method used to accomplish this result should be written plainly, so that it will be understood by all concerned, and sent to the Survey, where copies can afterwards be obtained.

The wire gages should be tested under as nearly as possible the same conditions as those under which the height of the water is measured, that is, with the weight hanging vertically. A substantial mark or stop should be so placed that the upper or lower end of the weight will be brought against it, and a moderate pull given to the wire will remove all kinks or bends. The best weights for these gages are the ordinary ones used for window sashes, weighing from 7 to 10 pounds each. The weight should be attached to a flexible wire or chain. The most satisfactory is probably one of the composition or brass chains used for heavy windows, as that stretches less than a twisted wire. Objection to the chains, however, is found in the fact that in exposed positions they are more likely to be stolen than is the wire. It is preferable to box in the chain or wire by long narrow strips placed horizontally on the bridge. One of these strips can be arranged as a cover, so that access to the wire can be had. This cover can be hinged and held in place by a padlock. With such an arrangement the chain is usually not disturbed.

A MEASURING VELOCITY OF WATER FROM BRIDGE, MISSISSIPPI RIVER AT ANOKA, MINN. (ELLIS METER).

B MEASURING VELOCITY OF WATER BY MEANS OF BOAT AND CABLE, MISSISSIPPI RIVER ABOVE MOUTH OF CROW WING RIVER, MINNESOTA

Great care should be given to joining the cord or chain and the weight to the handle at the other end so that there can be no slipping. The wire cord should be placed through the eye of the weight, bent back, and carefully wound and tied. In the same way the handle, if used as the index, should be fastened firmly. It is preferable, however, to place the index beyond the handle, and in such a way that, although perfectly firm, it can, if the wire stretches, be moved for the purpose of adjusting. Any adjustment that is made should be reported at once, so that the records can be corrected.

BENCH MARKS.

Wherever it is intended that permanent records shall be kept it is of the greatest importance that the relation between the datum of the gage and one or more fixed points be determined. Such reference marks, generally known as bench marks and indicated by the symbol B.M., may consist of a United States Geological Survey standard bronze or aluminum tablet, or a copper plug set in a drill hole in a rock; or, in case neither of these can be had, a cross cut in a ledge, or the head of a wire nail driven into the root or stem of a tree, will serve the purpose. In every instance it is desirable to have more than one reference mark, in order to insure against removal or accident. A surveyor's level and leveling rod should be used in determining the difference in elevation between some stated foot mark on the rod and the bench marks. In the case of wire gages, aside from the precautions just mentioned the difference of elevation between the water surface and the bench mark should be obtained by leveling and the gage reading for that particular stage be noted, from which data a permanent relation can be deduced, and a gage, if found disturbed, can at any time be verified and reestablished in its former position.

Full descriptions of bench marks should be made and forwarded to the Survey, where they will be kept on file for future reference. Hydrographers are required to test, with the aid of a level, the correctness of each gage at least once a year; oftener if necessary.

STAY LINES AND TROLLEY EQUIPMENT.

When the velocity of the water is considerable—as, for example, more than 5 or 6 feet a second—the sounding line and meter are likely to be swept backward down the stream, so that it is often necessary to provide an additional stay line. This consists of a cable or smooth wire stretched across the stream from 50 to 100 feet above the bridge or cable from which measurements are made. A small twisted wire clothesline or sash cord can be used for the purpose. It should be anchored at both ends and supported in a manner similar to the main cable. On this smooth wire a small pulley is placed, which travels freely from side to side of the river, and from the pulley a small flexible cord leads diagonally downstream. This can be attached

to the end of the sounding rod, thus holding it in place; or a fine wire can be similarly fastened near the head of the meter, so that when the instrument is lowered it will be prevented from being carried backward or tilted by the force of the current. Usually the guy line adjusts itself as the hydrographer moves from one side of the stream to the other.

A method of manipulating this stay line from a bridge is shown

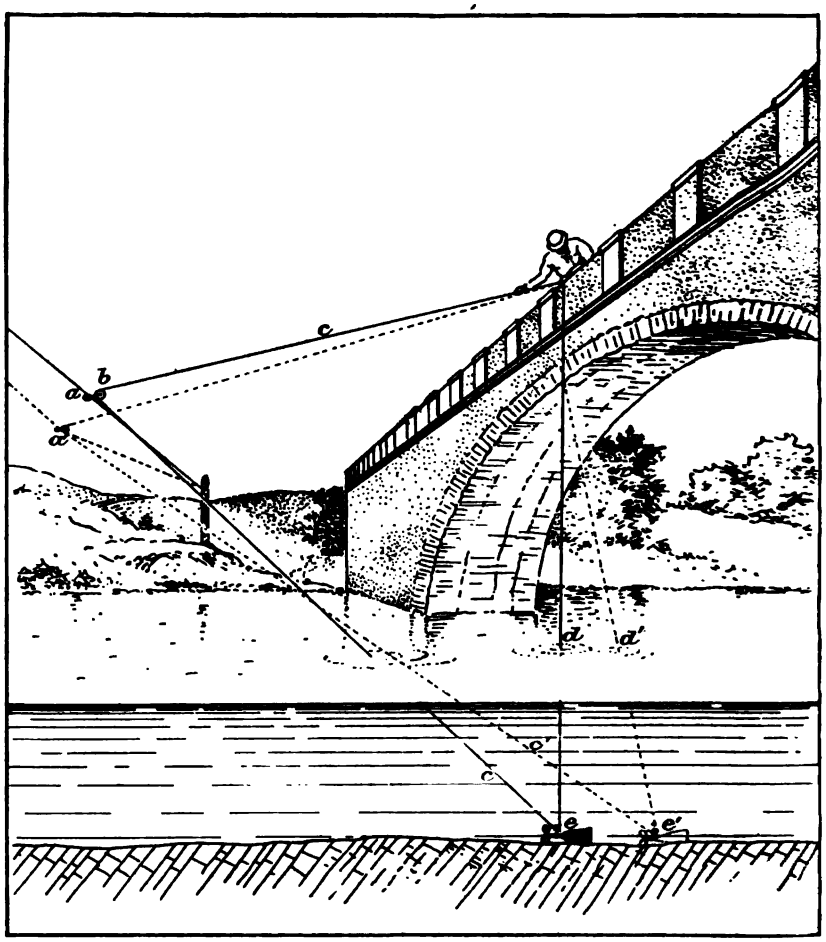


FIG. 1.—Method of manipulating stay line from small cable.

in fig. 1, in which case a small cable or stay wire is stretched across the river above the bridge, and a trolley or double pulley (a, b) is placed on it. The stay line (c) runs from the bridge to the small trolley (b) and back (c) to the meter (e). As the instrument is moved along the bridge the trolley on the cable follows the movement. The meter is raised and lowered by the cord d. When the meter is immersed in the swift water it is swept downstream and the cords are

A.

B.

MEASURING VELOCITY OF WATER BY MEANS OF BOAT AND CABLE, MISSISSIPPI RIVER AT ST. PAUL, MINN.

A, Preparing to make meter measurement; *B*, reeling in wire.

MEASURING VELOCITY OF WATER FROM SUSPENDED PLATFORM, RUM RIVER ABOVE MILL POND AT ANOKA, MINN.

stretched to the position a', e', d', but by a slight adjustment the meter can be drawn to the desired spot. Another device is shown in fig. 2.

A further use of stay lines has been successfully tried and adopted on a few streams where the conditions were favorable. It is known as the cable and traveler method, and is described in the Eleventh Annual Report, Part II, page 16. By means of a suitable number of wires and cords it has been found possible to hold the meter at different places

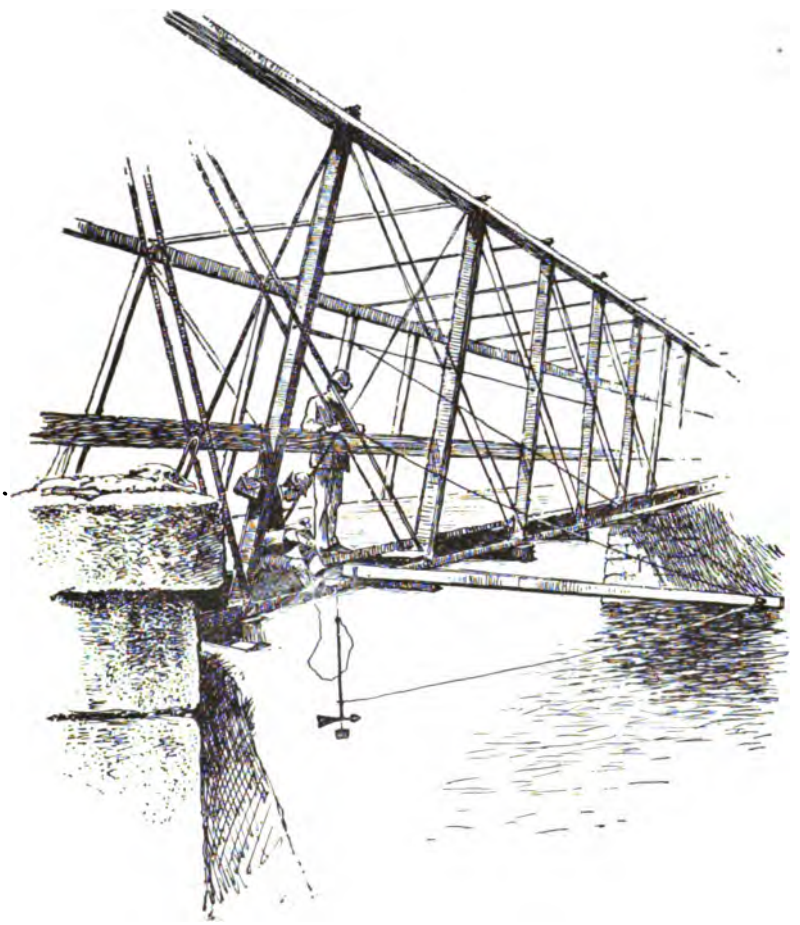


FIG. 2.—Method of attaching stay line to meter by use of pole.

in the stream while the hydrographer remains on the shore. The meter is run out on the main cable by means of halyards, and is lowered and raised by a double incandescent-light cord, or insulated wire, which serves the purpose of conveying the electric current from the battery and instrument on shore to the meter and of acting as a suspending and sounding cord. The stay line just mentioned is fastened to a pulley which travels across the river on a second smaller cable placed above the main cable. The lower end of this stay line holds the meter

and prevents it from being swept downstream. By manipulating the various ropes the meter can be held in any position in the cross section, the revolutions being reported by an electric sounder near the observer.

In the same manner soundings can be made quickly and accurately, the rod being held in a vertical position by the stay line, and the depth, if necessary, being read from the amount of movement of the cords on shore, the sounding and insulated circuit cord being graduated to correspond with the marks on the sounding rod.

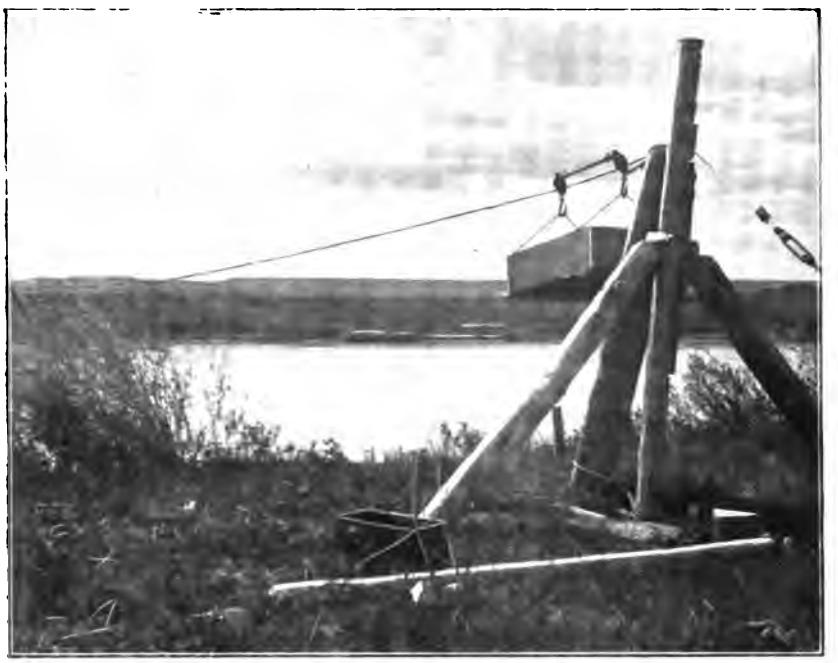
With careful training and experience one man can do all of the work of gaging more easily, it is probable, by this method than by any other. As stations are at present located, however, in most of the basins it is necessary for the hydrographer to have an assistant, and even at stations which can easily be reached by rail it is found economical to employ the resident gage observer, for the few hours consumed in making the measurements, as helper or recorder of notes.

At time of high water it may be difficult to count the revolutions of the meter, owing to the velocity of the current. It may even be impossible to keep the meter in the water, the tendency of the current being to throw it downstream and toward the surface. It is sometimes possible, however, to obtain a count of the revolutions of the meter by means of an electric counter when the speed is several times greater than can be counted by the hydrographer from observation.

OBSERVERS.

The work of reading gages requires no special educational attainments, the main requisite being faithfulness and regularity in the discharge of the duties assigned. It is generally advantageous to employ persons who from long residence in the locality are familiar with the river and evidence an interest in the matter. The hydrographer should satisfy himself that the observer fully understands his duties, and he should spare no pains to make clear the manner of reading the rod, calling attention particularly to the fact that the graduations are feet subdivided into tenths and not into inches. Instructions should be left with the observer, telling him how to proceed in case of accident to the gage, and to telegraph the fact to the hydrographer in charge of the station. A book (form 9–175) is furnished the observer in which to record each day the stage of the river and the time of the observation. At the end of each week he is required to fill in a mailing card (form 9–176) containing the record for the week, and send it to the hydrographer in charge of the station.

The blanks provided for the use of the observer have space for remarks. This space is intended, as is noted at the bottom of the blank, for the insertion of facts concerning rain, snow, change of weather, and other conditions likely to affect the height of the stream. It is expected that during floods notes will be made of the rate at which the water rises, of the extreme height reached, and of the hour at which the maximum stage occurs. Observers are likely to care-



A.

B.

GAGING APPARATUS IN POSITION, BLACK FORK OF GREEN RIVER NEAR GRANGER, WYO.

A, Cable and car; *B*, wire gage.

lessly omit memorandums of this character, and their attention should be called to the matter from time to time, for it is essential that these minor details be noted, in order that the changes in the height of the stream may be interpreted correctly.

In case of a sudden rise of the stream frequent readings should be made, and at the time the observer is hired he should be instructed when and how often to make extra readings; otherwise in "flashy" streams a flood may pass between two observations without being noted. When practicable the resident hydrographer should arrange for the observer to telegraph him when an unusually high stage seems imminent, so that high-water measurements can be made.

The remuneration paid to observers varies from $2 to $5 a month, according to the distance they live from the place of observation and the extent of their duties.

The principal work of the hydrographer is the measurement of the streams at the stations in the district assigned to him, but his supervision of the stations should be such that he will know that the local observers are careful and accurate in their readings and reports. At the time a station is established the reasons controlling the selection of that particular locality should be carefully recorded, and after the work is begun vigilance should be exercised to see that the records of the gage heights and the discharge measurements made can by proper interpretation be converted into quantities of discharge. The observer should be required to fill in the blanks fully and carefully, for these original records are preserved in the files of the Survey. Carelessness in forming the figures or in omitting the dates or other details should be promptly checked, and reports of that character should be copied at once and returned to the observer with the request that the details lacking be supplied.

One of the greatest difficulties in the work as now conducted is to obtain accurate and reliable reports from the observers, who are not at all times alive to the importance of accuracy. For this reason the readings of the observers should be verified occasionally, and if there is a well-founded suspicion that at any time heights are reported which are not actually observed, the observer should be reprimanded and if necessary the station be discontinued. It is better to discontinue a station than to have records that are open to suspicion. In a case where it is impracticable for the observer to make regular readings the fact should be noted in the report, in the "Remarks" column, and he should have impressed upon him the fact that it is better to report that observation was not made than to attempt to fill in the blank by guessing at the gage height. The observer should also be carefully instructed regarding the best method of making the readings, and he should be cautioned against reading at too great a distance a vertical gage on a pier from a position on the bridge at which estimates can not be made nearer than two or three tenths.

CARE OF INSTRUMENTS.

Hydrographers are responsible for the care of current meters and other instruments of the public property intrusted to them, and are required to account at stated times for all such property in their keeping. Since the accuracy of stream gagings depends largely upon the correct working of the current meter, great care should be exercised in handling these instruments and in keeping them properly adjusted. Inaccurate work and poor results can be traced directly to neglect in caring for instruments.

The following description and suggestions regarding the use and care of the small Price electric current meter (see Pl. XI) are intended for the guidance of hydrographers in the field.

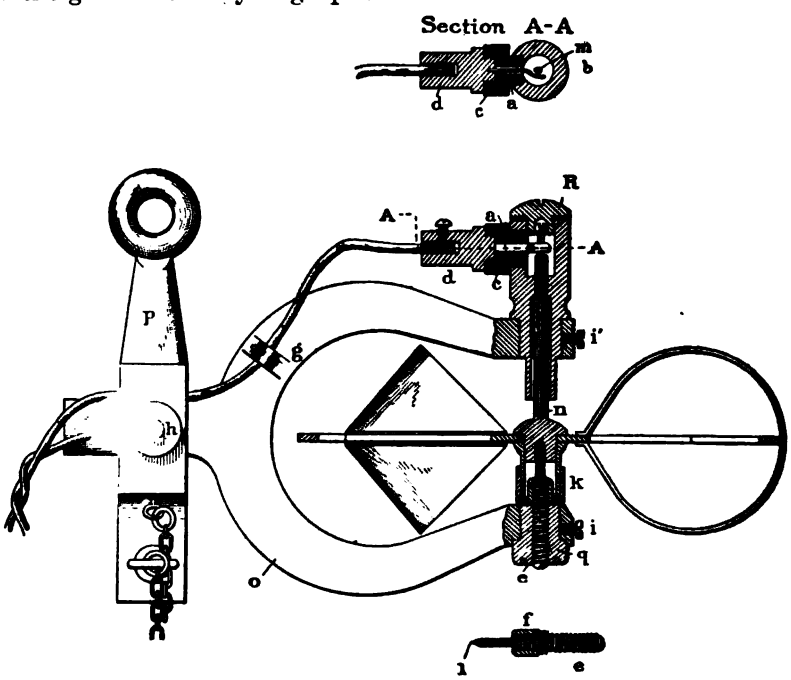


FIG. 3.—Cross section of small Price electric current meter, showing details.

When in use the meter is suspended by a double conductor cable of No. 14 or No. 16 flexible copper wire, heavily insulated. Wire of that size is of sufficient strength to hold the meter and weights, and it obviates the necessity of additional rope for suspending the equipment. The cable is attached to the meter with a spring snap hooked into the circular end of the trunnion *p*, fig. 3. The heavy copper wires are connected with the meter binding posts *h* and *d*, fig. 3, with smaller and more flexible wires. The wire connected with the binding post *d* should be threaded through the metal loops on the yoke *o*, within the trunnion frame and at *g*. It is desirable that these wires should be flexible and loose to allow the meter to swing free in the vertical plane when it is in use.

PRICE ELECTRIC CURRENT METERS WITH BUZZERS.

Lead weights (*a*, fig. 4) are attached to the lower end of the trunnion by means of a detachable weight stem (*b*, fig. 4), to hold the meter steady in moving water—the higher the velocity of the stream the greater the weight.

The weight vane (*c*, fig. 4) should be attached to the weights at all times when the meter is used suspended from a cable. When gaging small or shallow streams it may be necessary to make the observations by wading. Under such circumstances it will be more convenient to dispense with the lead weights and attach the meter to a light rod or pole. If desired a brass standard can be supplied for attaching the meter to the pole.

The meter is supported in a trunnion or hanger (*p*, fig. 3), and is free to swing in a vertical plane. One revolution of the wheel or cups is indicated by a buzz of the electric buzzer—the observer being required to count the number for a certain interval of time, preferably 50 seconds, as the computations can more easily be made from that number. A second observation of the same length of time should immediately follow the first observation, in order to verify the count.

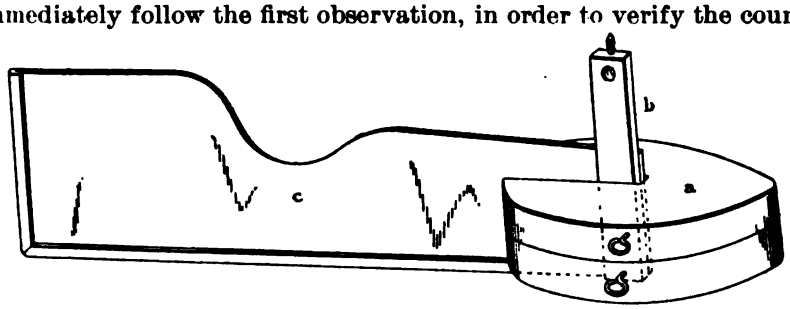


FIG. 4.—Weights and weight vane of small Price electric current meter.

The vertical axis (*n*, fig. 3) bearing the cups of the current meter, and hereinafter referred to as the cup shaft, terminates at the lower end in an inverted cone, which bears or turns on the cone-shaped point of *e*, fig. 3. The part marked *l*, fig. 3, will be referred to as the point bearing. This is the most delicate part of the meter, and should be given the greatest care, as it is made of highly tempered steel and is liable to be fractured or broken. To protect this sharp point bearing during shipping or carrying the meter, a milled sleeve (*k*, fig. 3) is provided. This sleeve is threaded on the inside, and screws up or down on the screw thread on the extension of the lower end of the cup shaft shown in fig. 3. When the meter is not actually in use, and before putting it into the wooden case after using, see that the milled sleeve *k* is screwed down until it bears on the top of *q* and raises the cups and cup shaft off of the point bearing, thus protecting it from possible injury. It is not necessary to screw this sleeve down very tight, and if it is screwed down tight the shoulder of the journal on the upper end of the cup shaft will be thrust hard against the end of its bearing and perhaps be injured.

When preparing to make a measurement with the meter the milled sleeve should be screwed up on the cup shaft as far as it will go, so as to be absolutely certain that the cups are turning on the point bearing and are working with the least possible friction. This sleeve is milled for adjustment with the fingers and not with a wrench or pliers.

If it becomes necessary, on account of injury, to replace the point bearing, an extra one will be found in the meter case. To replace the bearing slacken the screw *i*, fig. 3; with the small spanner wrench provided with the meter remove the large nut *q*, with the point bearing locked in it. After its removal hold the head of nut *q* firmly with a small wrench or pair of pliers, slip the small spanner wrench over the flat sides of the nut *f*, and loosen it. Remove the nut *f* with the fingers, and with a small screw-driver take out the damaged point bearing from the large nut *q*. Replace the large nut *q*, and with the spanner wrench screw it firmly into the yoke *o*. Remove the lock nut from the new point bearing to be inserted, and with a screw-driver send the latter through the large nut *q*. Great care should be exercised in making this most important adjustment of the current meter. A slight amount of play or movement of the cups up and down must be allowed, so that they will revolve freely and without friction. When the point is almost up turn it a part of a revolution at a time, with the screw-driver, until the proper adjustment is obtained. After the adjustment has been made a full turn of the point bearing in the nut *q* would crush the sharp point of the bearing *e* into the inverted cone of the cup shaft and break the point. After the point has been satisfactorily adjusted remove the nut *q*, with the point in it, put the lock nut on the point, and draw it down on the face of the large nut, taking care while turning it not to allow the point to turn in the large nut and thus disturb the adjustment. Should the adjustment of the meter be too tight the results obtained from its use will be erroneous. An examination of the meter when received from the Survey will give an idea of the proper adjustment. Do not disturb the adjustment of the meter unless it is necessary to put in a new point bearing.

Section *A–A*, fig. 3, shows the construction of the binding post and contact spring of the meter. A flexible, well-insulated copper wire (No. 20, or smaller) is drawn through the metal loop *g* of the yoke *o*; the end of the wire free from the insulation is thrust into the metal binding post *d* and secured by the small set screw. This metal binding post terminates in a slender platinum spring (*a*), which extends through the hard rubber nipple *c* into the contact chamber, to *m*. The top or upper end of the cup shaft terminates in the contact chamber with an oval-shaped eccentric (*m*), which makes a contact with the spring *a* at each revolution of the meter cups. This contact can be prolonged or shortened by bending the point of the contact spring in the contact chamber in the desired direction. The oval-shaped eccentric end of the cup shaft is detachable, and can be

removed by taking off the cap *R*, holding the cups firmly, and applying a screw-driver to the small slotted head.

The insulating nipple *c* is made of hard rubber, and is likely to break if the binding post *d* receives a sharp blow. An extra insulating nipple will be found in a small tin case in the meter box. Before removing or replacing the binding post *d*, take out the eccentric-shaped top of the cup shaft. If this is neglected the contact spring will be destroyed by the turning of the binding post.

In charging the battery cell used with the electric buzzer furnished with the current meter, one-half teaspoonful of bisulphate of mercury is sufficient. Fill the cell with water and insert the zinc pole with the rubber stopper attached. When putting the battery cell in the leather case be sure that the small platinum point on the lower end of the cell and the screw head of the rubber stopper make perfect contact with the copper plates. If the buzzer makes but a faint clicking sound instead of a buzz, remove the metal cap covering the buzzer, and with a knife blade adjust the small upright brass point, by bending until the armature produces the desired sound. Never allow the liquid to remain in the battery cell over night, as it will generate gas and produce pressure sufficient to cause the cell to leak at the rubber stopper, and the solution escaping will destroy the leather of the case and the brass parts of the buzzer.

Care should be exercised in the use and handling of the meter that it does not get a fall or hard knock, thus injuring the cups or cup shaft. An injury to either will change the rating of the meter, and it should be immediately returned to the Survey for repairs. When using the meter in streams containing grass or moss, examine the instrument frequently to see that nothing has lodged or wrapped around the cup shaft *n*.

When preparing to make a discharge measurement charge the battery cell of the buzzer; remove the meter from the case; take out the weights, weight stem, and vane, combine them as in fig. 4, and attach them to the meter with the spring pin provided; turn up the milled sleeve *k;* and turn the cups to see that they revolve freely and that the buzzer responds to each revolution.

After making a discharge measurement, or at the close of a day's work with the meter, unscrew the large nut *q*, with the point bearing in it, and examine the point carefully to detect injury. With a piece of soft cloth remove the water in the opening at the lower end of the cup shaft, oil generously, and replace the bearing. Then remove the screw cap *R*, turn the meter over to allow the water to run out of the contact chamber, put in a plentiful supply of oil, and replace the cap; this protects the top or journal bearing of the cup shaft from rusting. After this has been done turn down the milled sleeve *k*, to protect the point bearing while carrying the meter, remove the battery cell, empty out the liquid, wash the cell with water, and pack the meter carefully in the case, when it will be ready for future use.

METHODS OF RATING METERS.

Each current meter when received from the factory, and subsequently when repaired, is rated by running it through still water, the assumption being that the same relation will hold between the turns of the instrument when running through still water as when held in one position in flowing water. This relation is obtained by fastening the meter in a position comparable to that in which it will be held when in use in the stream. That is to say, if the meter is to be used fastened rigidly to a rod, it is rated in that manner; if, on the other hand, it is to be used on the end of a flexible cord the rating is accomplished under those conditions.

Two devices for rating meters are shown in Pl. XII. The upper illustration is of the equipment used by the Survey at its rating station at Chevy Chase, a suburb of Washington, D. C., the lower picture is of the device employed at Los Angeles, Cal. The apparatus used at Chevy Chase consists of a platform, about 200 feet in length, built along the edge of a small, deep pond the waters of which are practically stagnant. On the outer edge of this platform are small iron rails, on which is placed an ordinary mine car or truck, with outrigger so that the meter can be held vertically over the water and immersed to the desired depth. On the platform a measured course of 100 feet is laid off, and the car is pushed by hand, care being taken to pass over every 10 or 20 feet in a uniform number of seconds, so that the same velocity can be maintained from start to finish. In the view a meter is shown suspended from the car on the right-hand side, and another meter is shown in the background against the door of the house in which the car and smaller tools are stored.

The device used at Los Angeles, Cal., consists of a cement-lined trough along the edge of the reservoir. Above this is stretched an iron cable, suitably supported, on which is a trolley with two wheels, by means of which the meter is supported beneath the surface of the water. The meter is propelled through the water over a measured course, usually 100 feet, for 20 or more times in succession, the speed varying from less than 0.5 foot per second to 6 or 8 feet per second, or even more, the number of revolutions per hundred feet and the number of seconds being noted. Thus there is obtained the feet per second and the revolutions per second at different speeds. When these data are plotted upon cross-section paper it will be found that for higher velocities the points lie in a nearly straight line, but for lower velocities there is a tendency for the revolutions per second to decrease, owing to the slight friction in the instrument. A broken or somewhat curved line is therefore sketched for the lower velocities, and from this curve values are taken to make the arbitrary table of the relation between the revolutions of the meter per second and the speed of the water. This table is found to be fairly constant until the meter becomes injured or the friction notably increases by the wearing away of the more delicate points of the bearings.

A.

B.

APPARATUS FOR RATING METERS.

A, At Chevy Chase, Md; *B*, at Los Angeles, Cal

In using current meters, especially those suspended from a cord or line, it frequently happens that in swift water the instrument is swept backward and tipped at an angle from the horizontal, either momentarily or for a considerable period of time. In order to obtain data concerning the reliability of results under such conditions a series of tests was made at the Chevy Chase rating station. A small Price current meter was used, being held rigidly at various angles as measured from a horizontal line. The results are given in the Nineteenth Annual Report, Part IV, page 27.

At an angle of 5 degrees, with a velocity below 4 feet per second, the meter apparently revolves a trifle faster than when it is horizontal. In other words, at moderate speeds and at low inclination the meter may indicate a slightly higher velocity than actually exists. At high speeds, however, and at a high inclination, the reverse is true, as the meter turns more slowly than when held perfectly parallel to the current. When depressed beyond 25 degrees the resistance to the current approaches that offered by the tail, and the meter swings about in a position nearly at right angles to the current, causing the head to approach the normal or zero angle.

NOTES AND COMPUTATIONS.

The ordinary method of computing discharge from the observations is indicated by a small field notebook (form 9–198) ruled for the purpose. The velocity at each element of the section of the stream is ascertained by observations at various depths, as previously described. The area of each element or fraction of the section is obtained by multiplying the width by the mean depth. The discharge is the product of the velocity by the area, and the discharge of the whole section is the sum of these products. This has been found to be, under usual circumstances, the most convenient method of computation. It is desirable that soundings in the cross sections be made at regular intervals and at the same points in the stream. In this way changes in the river bed will be noted, and if the gage is broken or displaced the soundings will often furnish data for an approximate computation of the mean depth for resetting the gage.

Referring to the notebook (form 9–198), at the top of the page are spaces for recording the date, the name of the hydrographer, the number of the meter, the locality, the height of the water at the time of beginning and ending the measurements, also the average height, and whether the river was rising, falling, or stationary. On the opposite page is space for inserting the results, i. e., the total area, the mean velocity, and the total discharge in cubic feet per second. On the extreme left are double columns for recording the soundings, the first column being for the distance from the initial point and the second column for the depth at that particular place. The following table shows the method of recording and computing discharge measurements in the notebook (form 9–198):

Sample page from notebook, showing method of

Gaging made (January 26, 1898), by (E. G. Paul and G. H. Matthes). Meter No. (95). Gage height: beginning (7.5) ft., ending (7.6) ft.; mean (7.55) ft. River rising, falling, stationary.

Soundings.		Observations.						
Distance from initial point.	Depth.	Depth of observation.	Time, in seconds.	Register reading.			Revolutions per second.	Velocity per second.
				Begin.	End.	Diff.[1]		
60	4.8							
65	5.3							
70	5.2	⅜	50			33	0.66	1.60
			"			33		
75	5.3							
80	5.2	"	"			48	0.97	2.35
			"			49		
85	5.							
90	5.4	"	"			64	1.28	3.09
			"			64		
95	5.3							
100	5.3	"	"			77	1.54	3.72
			"			77		
105	5.2							
110	5.4	"	"			81	1.62	3.91
			"			81		
115	5.5							
120	5.8	"	"			98	1.94	4.68
			"			96		
125	5.7							
130	6.3	"	"			36	0.72	1.75
			"			36		
135	6.7							
140	6.4							
173	1.7							
185	2.4							
190	3.9	"	"			88	1.77	4.27
			"			89		
195	4.7							
200	4.8	"	"			85	1.70	4.10
			"			85		
205	5.3							
210	5.1	"	"			80	1.59	3.84
			"			79		
215	5.0							
220	4.9	"	"			68	1.35	3.26
			"			67		
225	4.5							
230	4.3	"	"			62	1.24	3.00
			"			62		
235	4.0							
240	4.0	"	"			50	1.00	2.42
			"			50		
245	4.1							
250	3.8	"	"			23	0.46	1.12
			"			23		
255	3.3							
260	3.0	"	"			3½	0.07	0.19
			"			3½		
270	1.2							
Total								

[1] The figures in this column are the number of revolutions of the meter in 50 seconds, a recorder not being used.

recording and computing discharge measurements.

At station (Frederick, Md.), on (Monocacy) River. Total area (808) sq. feet. Mean velocity (2.90 feet). Discharge (2,342) second-feet.

Section.			Discharge of section.	Remarks.
Width.	Mean depth.	Area.		
				Edge of still water.
15	5.15	77.3	123.7	
10	5.20	52.0	122.2	
10	5.30	53.0	163.7	
10	5.27	52.7	196.0	
10	5.37	53.7	210.0	
10	5.70	57.0	266.7	
15	6.35	95.2	166.6	
				Edge of still water.
				Edge of second channel.
22	2.81	61.8	263.8	
10	4.90	49.0	200.9	
10	5.13	51.3	197.0	
10	4.82	48.2	157.1	
10	4.27	42.7	128.1	
10	4.03	40.3	97.5	
10	3.75	37.5	42.0	
15	2.45	36.7	7.0	
				Edge of still water.
177		808.4	2,342.3	

At all river stations, besides the bench marks for the zero of the gage rod, there should be chosen an initial point at which to begin all soundings. This initial point may be some permanent object on the bank, the end of a bridge, or the edge of a pier. A bench mark should be permanent, easily identified, and in such position that it will always be a short distance beyond the high-water mark. Starting from this initial point the soundings are usually made every 10 or 20 feet, or, in the case of very small streams, at intervals of 5 feet.

The first sounding should be at the edge of the water, and its distance from the initial point should be recorded in the notebook, the sounding being registered as zero. The last sounding should be at the farther edge of the water, and should be noted as so many feet from the initial point and as zero in depth. If intermediate islands or bars project above water the fact should be recorded in the notebook, also the distance of both margins from the initial point. This greatly simplifies the comparison of subsequent changes of depth.

To the right of the columns for soundings are spaces for the observations, including depth of observation, or number of feet and tenths below the surface of the water at which the meter is read, and the number of seconds, usually 50 or 100, during which the revolutions of the meter are noted. To the right of these are three columns for use in case a recording register is used with the meter. The first of these is for the register reading at the beginning of the observation, the second is for the reading at the end of the number of seconds (50, 100, or more) during which the revolutions are counted, and the third is for the difference between these two readings. In cases where the revolutions of an electric meter are counted by listening to the sounder, as in the sample computation on pages 36 and 37, the third column only is used. It is customary to make two observations of 50 seconds each at a point, and if these do not agree to make a third, and a fourth if necessary, continuing until it is ascertained whether there may have been any accidental irregularity in the behavior of the instrument. If these observations appear to have equal value the average of all is taken; if one or more are of doubtful value the doubtful ones are rejected.

The number of revolutions of the meter as recorded in the column of differences divided by the number of seconds gives the revolutions per second to be inserted in the column headed thus. Where two observations of 50 seconds each have been made it is necessary merely to add the revolutions and point off two places.

The observations for velocity per second are usually taken not only at intervals across the stream but also at the top and near the bottom at each locality and at intermediate points. Where the stream is shallow it has been found that the average of the observations taken slightly below the surface and above the bottom at a distance where the meter runs freely, represents very closely the mean velocity of the

section. In deeper streams the mean velocity of the vertical section can be obtained by observations at a large number of points, or by assuming that the measurement obtained at a distance below the surface of three-fifths of the depth is the mean velocity, as more fully described on pages 18 and 19. Taking, therefore, the average of the velocities in the vertical plane as obtained in either way, it is assumed to represent the average velocity for a portion of the river on both sides of the plane, which is taken parallel to the course of the stream and as extending halfway to the points of observation on each side. If these points of observation are 10 feet apart the width of the section is taken as 10 feet and is entered in the proper column.

In the case of a broad, smooth channel the mean depth of the section is taken as the depth of water at the place where the meter is run, or as an average obtained by adding the depth of water on each side halfway to the next point of observation, adding to this twice the depth where the meter is run, and dividing the whole by four. This mean depth, in feet, multiplied by the width, in feet, gives the area of the section, in square feet. This area multiplied by the velocity per second, as given in the column headed thus, gives the discharge, in cubic feet per second, or second-feet, to be inserted in the column thus designated. The sum of the discharges of the various sections is the total discharge of the river. This is inserted at the top of the page. The sum of the individual areas is the total area, in square feet, to be inserted also at the top of the page. The mean velocity of the whole stream is the discharge, in cubic feet per second, divided by the total area thus obtained, but it is not the average of the velocities per second as measured by the current meter.

In the sections of the river adjacent to the shore special care must be taken in the computations, as the current is often so sluggish that the meter will barely revolve, and at times reverse currents creep up along the bank. Allowance must be made for all of these factors, also for still or dead water. In computing the average depth of the triangular sections at each end the depth at the shore is taken as zero, this being added to the other depths and the total divided by four, as in the case just described. Where the current is running diagonally to the channel of the stream, allowance for that must be made in the width of each section. The notebook is provided with space, under the head of "Remarks," for these details and for comments upon the accuracy of the measurement.

In making the computations in the notebook it is undesirable to carry them out to a degree of refinement not warranted by the original observations; that is to say, if the meter reading is only to whole numbers it is a waste of time to make computations to more than one point of decimals, or, in fact, to employ decimals at all except as a safeguard against errors creeping into the last figure of the results.

The hydrographer should occasionally look over the measurements

made during the year and determine whether or not a sufficient number have been made for the construction of a rating curve for each station. If either high-water or low-water measurements are lacking a special effort should be made to reach the station during that stage of the stream, so that doubtful parts of the rating curve can be accurately constructed. One of the chief difficulties encountered in working up the field notes is that a number of measurements will be made at the ordinary flow of the stream and none during high-water and low-water stages.

It is very important that hydrographers carefully check and revise all records before they are sent to the Survey; but if mistakes are found after the records have been sent to Washington a detailed description of them should at once be prepared and forwarded, so that the records on the books of the Survey will be accurate and complete. Occasionally annoyance is caused by carelessness in this matter, and after computations of the discharge of a stream are worked up at the Survey notification is received of errors in the gage readings, or of the displacement of the gage, which vitiates the records on file.

REPORTS OF DISCHARGE MEASUREMENTS.

The field notebooks (form 9–198) referred to are to be retained by the hydrographer as long as required and ultimately forwarded to the Survey for preservation with other original records. In order to report the results as soon as possible, however, a blank (form 9–197) has been provided which gives space for the date, the locality, the name of the hydrographer and his assistant, and for a memorandum concerning the number and page of the notebook on which the computations are made. Under the head "Description of river stations" is space for a description of the location of the station, the date when originally established, the name and address of the observer and his pay, occupation, and the distance which he is required to travel in order to make readings, also the time of day at which the readings usually are made. A line is also added on which to record the fact whether the observer is reliable and is taking a proper interest in the results of his work, and space is provided for memoranda concerning the equipment and the condition of any Survey property at the station. Attention is also called to the condition of the gage, and descriptive words are inserted in order that by striking out those not applicable the words remaining will indicate whether the gage is in good order or needs attention. Space is also left for comments on the bench marks, whether the initial point for sounding is on the right or left bank, whether the channel both above and below the station is straight or curved, the water swift or sluggish; also for the height of the banks, whether high or low, the character of the bed of the stream, and similar details. Any changes in the channel shown by soundings should also be noted.

Where possible two or more gages are established at each station, being connected by level lines, so that the slope of the water surface can be read at various elevations. Assuming a value of n for Kutter's formula of discharge, it is possible to estimate the discharge by computation based upon the slope. This should be done and the product be compared with the measured result, in order that the hydrographer may obtain data regarding the application of such formulæ and the value of the constant (n) to be applied in each case.

The results of the measurement itself are to be given on the lower part of the blank, the first item being the height of water and its condition, whether rising, falling, or stationary, the inapplicable words being stricken out for the latter purpose. The total width of the channels and their number should also be given. Space is provided for an abstract of the field notes, giving, for important points, the distance from the initial point, the depth, and the mean velocity. This is for the purpose of showing concisely the character of the stream. It is not intended to insert fully all of the observations, but simply selected ones which will bring out essential facts most clearly. The make and number of the current meter used should also be given, or if measurements are made by means of floats or over a weir the fact should be stated. The velocity and direction of the wind should also be recorded, as they have considerable influence upon the behavior of the stream. In some cases, especially in extremely hot or cold climates, it is also desirable to have the temperature of the water and the air. A line is also provided on which the hydrographer should note any possible cause of error; and, finally, space is provided for a statement of the mean, minimum, and maximum velocities, the total area of the section in square feet, and the total discharge in second-feet. On the back of the sheet a sketch should be made showing the position of the gage, the bridge, or cable from which measurements are made, the bench marks, the initial point of sounding, etc. Where a number of measurements are made in succession at one point, it is of course unnecessary to fill in all of the details each time; but in cases where the hydrographer visits a station at long intervals, and after changes due to floods have taken place, all of the facts should be carefully noted, in order to show the extent of the changes and to indicate clearly that certain details are unchanged.

In reporting measurements of discharge it is not desirable, except in cases of exceedingly small amounts of water, to give the results to decimals of a second-foot, for a false idea might be given regarding the accuracy of the measurements. Velocities should be given in feet and hundredths of a foot per second, and, for uniformity, the height of water on the gage in feet and hundredths of a foot. In statements of this kind attention should be paid to the accuracy of the data. The field work should be conducted with the greatest care, but, on the other hand, the computations made in the office should

not be carried out to a degree of refinement inconsistent with the original work.

In work of this character accuracy has been and always will be a subject for debate. At the outset it should be recognized that in the measurement of flowing water either above or under ground the precision of ordinary engineering operations is not attainable, because the quantities to be measured are not fixed, but fluctuate to a notable extent even during the process of measurement. We can ascertain the width of a river by fixing arbitrarily two points which shall represent the sides, but here an assumption comes in as to what shall be considered the sides, and usually there is a latitude of several feet. We can measure the depth if we assume some fixed object as representing the bottom. But for the top surface, even when artificially stilled, there is usually a pulsation ranging from 30 to 50 seconds or more and giving a vertical oscillation through several hundredths of an inch, so that judgment must be exercised in that also. When we come to the velocity, we have the widest possible range, not only in different parts of the cross section but at the same point during successive moments, and in determining that also judgment must be exercised. In other words, at every step of the operation of measuring a stream certain assumptions, which may affect the total by from 2 to 5 per cent, must be made.

Engineers, and especially office men, who spend most of their lives compiling and digesting figures, are likely to lose sight of these primary assumptions, and in their desire for accuracy of computation to express results in decimal figures, which, if we pause to consider the primary assumptions, is generally, except in the case of very small streams, not only ludicrous but misleading. In all questions of original investigation, like that of the water resources of the country, this element of primary assumption must constantly be borne in mind in considering the plan of work and the results attained. In the practical application of the figures of flow of water above or under ground the tacit assumption is that the results obtained at one time will again prevail. If, for example, the midsummer measurements gave a stream discharge of 100 cubic feet per second, engineers and others concerned will quote this figure and use it in their estimates, although, if they stop to think, they will admit that the stream may never again discharge an equal volume, but that the low water in other years or for an average of years may be greater or less than this one measurement indicates. Yet there are those who will recompute the data and take great satisfaction in expressing the measurement as 99.63 cubic feet per second, when they should know not only that there is an error of plus or minus 2 per cent in the result, but that the stream may next year discharge half or twice as much at the same season.

FLOOD ESTIMATES.

At the highest floods, when it is impossible to use a current meter, it is desirable to make an approximate estimate of the flow. This can be done by noting the speed of floating driftwood and other débris on the water surface—by placing a certain base line on the shore parallel to the current, and noting the time that it takes the drift to pass over a certain distance. It will generally be found that the velocity at the center of the stream is greater than toward the edges, and it is well to make estimates of the surface velocity at various points across the stream. From these velocities and a rough estimate of the areas controlled by the various velocities an approximate estimate of discharge can be made. Notes should accompany such estimations describing just how they were obtained, so that a false idea of the accuracy of the measurement will not be conveyed. Records of this kind are often of the greatest value to engineers and investors, in cases where it is not important to know within 10 or even 20 per cent the maximum discharge of a stream, but where it is important to know its discharge within 30 or 40 per cent. Many cases are on record where, without any data upon which to base an estimate, assumptions of the maximum discharge of streams have been made which afterwards were found to be in error by 200 or 300 per cent.

If it is impracticable to make even a rough estimate of the flow of a stream at its maximum discharge, the hydrographer should at least note on the bank, bridge pier, or other permanent landmark the greatest height to which the water rises. It is also desirable to note the rapidity with which it rises and falls, and other natural phenomena.

RATING TABLES.

The immediate object of measurements made at a river station is the construction of a rating table, or series of tables, which shall show the relation for a given length of time between the height of water and the quantity flowing in the stream. In order to prepare such a table it is of course necessary to obtain the discharge at various stages of the stream, covering the ordinary range of fluctuation. This is a comparatively easy task if the channel does not change. The simplest method of procedure in constructing a rating table is to plot upon rectangularly ruled paper each point representing the gage height and the discharge for a given measurement, the vertical distance from the bottom line being taken to represent the height of water at the given measurement and the distance from left to right the quantity of discharge in cubic feet per second. For convenience, the measurements of discharge should be numbered consecutively from 1, the earliest, the numbers being placed opposite the points upon the rectangularly ruled paper. If there are a half dozen or more of these points well distributed according to height of water, it will usually be

found that they lie approximately in the path of a parabolic curve. This curve can be sketched through or near the points, the hydrographer, from his intimate knowledge, giving greater weight to some points than to others. This curve shows the relation of gage height to discharge for the particular times under consideration. The rating table is the numerical expression for the curve described. The next step is to read off the figures from the drawing, starting with the lowest value in the lower left-hand corner. The lowest horizontal line representing a tenth of a foot is followed from left to right until it intersects the curve, and the value represented by this distance is set opposite the tenth of foot taken. The line representing the next higher tenth of a foot is then followed out, and its length from the margin at the left to the curve at the right is also obtained, and so on, setting opposite each tenth of a foot the corresponding value of discharge. When the table has been prepared in this way it will be found that there is an increasing value for the discharge, and that the difference between the values is also constantly increasing. Owing, however, to the small scale upon which such a sketch necessarily is made, the figures read off from the drawing do not always have this constantly increasing value, some being proportionally too large and others too small. In order, therefore, to smooth out the curve, it is convenient to set off between the lines of the rating table the differences in quantity of discharge, making a third column. Upon running the eye down this column several points are quickly detected where the differences are not regular. Considering these, it will be seen that a slight adjustment of the differences and the addition or subtraction of a small amount from the figures of discharge will smooth out these irregularities. This adjustment should be made, and as a check upon the accuracy of the work the resulting figures, after the rating table has been smoothed out, should be plotted upon the original drawing to determine, by inspection, that the rating table as finally adjusted is accordant with the observations. This method of graphic construction avoids difficulties and liability to error in the use of the higher mathematics, and its accuracy is well within that of the original data.

The length of time during which a rating table can safely be applied to the observations should be determined by the hydrographer and noted upon it, in order that it may not be used beyond proper limitations. Where the channel is constantly shifting a table can not be used for many weeks or months unless it be referred to the readings of heights as interpreted by the occasional soundings.

TABLES FOR COMPUTING RESULTS FOR PUBLICATION.

The unit employed in the measurement of streams is the cubic foot per second. This is described in the Eleventh Annual Report, Part II, Irrigation, pages 2 to 5; also in the Fourteenth Annual Report, Part

II, pages 100 and 101. From this fundamental unit others have been derived, and the results of the investigation are shown in these for convenience of comparison. The tables formerly published give the maximum, minimum, and mean discharge, in second-feet, for each month. They also usually give the total discharge for the month, in acre-feet, and the run-off in two terms, viz, the depth in inches and the rate of flow in second-feet per square mile. The acre-foot of water is a quantity equivalent to an area of 1 acre covered 1 foot in depth, or 43,560 cubic feet.

Table for converting second-feet into acre-feet per day.

Days.	Second-feet.								
	1	2	3	4	5	6	7	8	9
	Acre-ft.	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*
1	1.98	3.97	5.95	7.93	9.92	11.90	13.88	15.87	17.85
2	3.97	7.93	11.90	15.87	19.83	23.80	27.77	31.74	35.70
3	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55
4	7.93	15.87	23.80	31.74	39.67	47.60	55.54	63.47	71.40
5	9.92	19.83	29.75	39.67	49.59	59.50	69.42	79.34	89.26
6	11.90	23.80	35.70	47.60	59.50	71.40	83.31	95.21	107.11
7	13.88	27.77	41.65	55.54	69.42	83.31	97.19	111.07	124.96
8	15.87	31.74	47.60	63.47	79.34	95.21	111.07	126.94	142.81
9	17.85	35.70	53.55	71.40	89.26	107.11	124.96	142.81	160.66
10	19.83	39.67	59.50	79.34	99.17	119.01	138.84	158.68	178.51
11	21.82	43.64	65.45	87.27	109.09	130.91	152.73	174.55	196.36
12	23.80	47.60	71.40	95.21	119.01	142.81	166.61	190.41	214.21
13	25.79	51.57	77.35	103.14	128.93	154.71	180.50	206.28	232.07
14	27.77	55.54	83.31	111.07	138.84	166.61	194.38	222.15	249.92
15	29.75	59.50	89.26	119.01	148.76	178.51	208.26	238.02	267.77
16	31.74	63.47	95.21	126.94	158.68	190.41	222.15	253.88	285.62
17	33.72	67.44	101.16	134.88	168.59	202.31	236.03	269.75	303.47
18	35.70	71.40	107.11	142.81	178.51	214.21	249.92	285.62	321.32
19	37.69	75.37	113.06	150.74	188.43	226.12	263.80	301.49	339.17
20	39.67	79.34	119.01	158.68	198.35	238.02	277.69	317.36	357.02
21	41.65	83.31	124.96	166.61	208.26	249.92	291.57	333.22	374.88
22	43.64	87.27	130.91	174.55	218.18	261.82	305.45	349.09	392.73
23	45.62	91.24	136.86	182.48	228.10	273.72	319.34	364.96	410.58
24	47.60	95.21	142.81	190.41	238.02	285.62	333.22	380.82	428.43
25	49.59	99.17	148.76	198.35	247.93	297.52	347.11	396.69	446.28
26	51.57	103.14	154.71	206.28	257.85	309.42	360.99	412.56	464.13
27	53.55	107.11	160.66	214.21	267.77	321.32	374.88	428.43	481.98
28	55.54	111.07	166.61	222.15	277.69	333.22	388.76	444.30	499.83
29	57.52	115.04	172.56	230.08	287.60	345.12	402.64	460.17	517.68
30	59.50	119.01	178.51	238.02	297.52	357.02	416.53	476.03	535.54
31	61.49	122.98	184.46	245.95	307.44	368.93	430.41	491.90	553.39

As the months are of varying length it is necessary to use three or four factors to convert the average discharge for the month in second-feet into the total in acre-feet. One second-foot flowing for twenty-four hours is equivalent to 86,400 cubic feet. Since there are 43,560 square feet in an acre there will be the same number of cubic feet in an acre-foot. Dividing, it is found that 1 second-foot for twenty-four hours very nearly equals 2 acre-feet, or, in exact figures, 1.983471 acre-feet. This multiplied by the number of days in the month will give the total monthly discharge in acre-feet. This quantity, therefore, must be multiplied by 28 for the month of February, or 29 for that month in leap year, and by 30 or 31 for the other months.

For the month of February when it has 28 days the factor to be used is 55.537188. For convenience in computation this factor multiplied from 1 to 9 is given on the following page:

1	55.53719
2	111.07438
3	166.61157
4	222.14876
5	277.68596
6	333.22315
7	388.76034
8	444.29753
9	499.83472

When February has 29 days the factor to be used is 57.520659. This when multiplied from 1 to 9 is as follows:

1	57.52066
2	115.04132
3	172.56199
4	230.08265
5	287.60331
6	345.12397
7	402.64463
8	460.16530
9	517.68596

Table for converting second-feet into acre-feet per month.

Second-feet.	Acre-feet per 30 days	Acre-feet per 31 days.	Second-feet.	Acre-feet per 30 days.	Acre-feet per 31 days.
1	59.504	61.488	51	3,034.711	3,135.868
2	119.008	122.975	52	3,094.215	3,197.355
3	178.512	184.463	53	3,153.719	3,258.843
4	238.017	245.950	54	3,213.223	3,320.330
5	297.521	307.438	55	3,272.727	3,381.818
6	357.025	368.926	56	3,332.231	3,443.305
7	416.529	430.413	57	3,391.735	3,504.793
8	476.033	491.901	58	3,451.240	3,566.281
9	535.537	553.388	59	3,510.744	3,627.768
10	595.041	614.876	60	3,570.248	3,689.256
11	654.545	676.364	61	3,629.752	3,750.744
12	714.050	737.851	62	3,689.256	3,812.231
13	773.554	799.339	63	3,748.760	3,873.719
14	833.058	860.826	64	3,808.264	3,935.206
15	892.562	922.314	65	3,867.768	3,996.694
16	952.066	983.802	66	3,927.273	4,058.182
17	1,011.570	1,045.289	67	3,986.777	4,119.669
18	1,071.074	1,106.777	68	4,046.281	4,181.157
19	1,130.578	1,168.264	69	4,105.785	4,242.644
20	1,190.083	1,229.752	70	4,165.289	4,304.132
21	1,249.587	1,291.240	71	4,224.793	4,365.620
22	1,309.091	1,352.727	72	4,284.297	4,427.107
23	1,368.595	1,414.215	73	4,343.801	4,488.595
24	1,428.099	1,475.702	74	4,403.306	4,550.082
25	1,487.603	1,537.190	75	4,462.810	4,611.570
26	1,547.107	1,598.678	76	4,522.314	4,673.058
27	1,606.612	1,660.165	77	4,581.818	4,734.545
28	1,666.116	1,721.653	78	4,641.322	4,796.033
29	1,725.620	1,783.140	79	4,700.826	4,857.520
30	1,785.124	1,844.628	80	4,760.330	4,919.008
31	1,844.628	1,906.116	81	4,819.835	4,980.496
32	1,904.132	1,967.603	82	4,879.339	5,041.983
33	1,963.636	2,029.091	83	4,938.843	5,103.471
34	2,023.140	2,090.578	84	4,998.347	5,164.958
35	2,082.645	2,152.066	85	5,057.851	5,226.446
36	2,142.149	2,213.554	86	5,117.355	5,287.934
37	2,201.653	2,275.041	87	5,176.859	5,349.421
38	2,261.157	2,336.529	88	5,236.363	5,410.909
39	2,320.661	2,398.016	89	5,295.868	5,472.396
40	2,380.165	2,459.504	90	5,355.372	5,533.884
41	2,439.669	2,520.992	91	5,414.876	5,595.372
42	2,499.173	2,582.479	92	5,474.380	5,656.859
43	2,558.678	2,643.967	93	5,533.884	5,718.347
44	2,618.182	2,705.454	94	5,593.388	5,779.834
45	2,677.686	2,766.942	95	5,652.892	5,841.322
46	2,737.190	2,828.430	96	5,712.396	5,902.810
47	2,796.694	2,889.917	97	5,771.901	5,964.297
48	2,856.198	2,951.405	98	5,831.405	6,025.785
49	2,915.702	3,012.892	99	5,890.909	6,087.272
50	2,975.207	3,074.380	100	5,950.413	6,148.760

For the months containing 30 days, viz, April, June, September, and November, the factor to be used is 59.5041300. This when multiplied by the unit figures is as follows:

1	59.50413
2	119.00827
3	178.51240
4	238.01653
5	297.52066
6	357.02480
7	416.52893
8	476.03306
9	535.53720

For the months containing 31 days, viz, January, March, May, July, August, October, and December, the factor to be used is 61.4876010. This when multiplied by the unit figures is as follows:

1	61.48760
2	122.97521
3	184.46281
4	245.95042
5	307.43802
6	368.92562
7	430.41323
8	491.90083
9	553.38844

The run-off per square mile is obtained by simply dividing the average for the month by the total number of square miles in the drainage basin, which is usually ascertained by planimeter measurements from the best map available. Being a rate of flow it is independent of time, and therefore the number of days in each month does not enter into the ratio.

The depth of run-off over the drainage basin is usually computed in inches for convenience of comparison with the depth of rainfall, which is almost invariably given in that unit. This depth can most conveniently be computed from the run-off per square mile by computation based upon the number of days in each month and the relation between the rate of flow and the depth in inches for this quantity were it held during the given number of days. One second-foot for twenty-four hours is equivalent to 86,400 cubic feet in one day. In other words, 1 cubic foot per second run-off from 1 square mile would, if held upon this area, cover it to a depth represented by dividing 86,400 by the number of square feet in a mile, 27,878,400, or 5,280 squared. Completing this division, it is found that 1 second-foot for one day is equivalent to a body of water covering 1 square mile 0.003099174 feet, or 0.037190082 inch. Multiplying this by the number of days in a month gives the following factors:

28 days	1.041322296
29 days	1.078512378
30 days	1.115702460
31 days	1.152892542

Table for converting second-feet per square mile into depth in inches per month.

Second-feet per square mile.	28 days.	29 days.	30 days.	31 days.
	Inches.	*Inches.*	*Inches.*	*Inches.*
1	1.041	1.079	1.116	1.153
2	2.083	2.157	2.231	2.306
3	3.124	3.236	3.347	3.459
4	4.165	4.314	4.463	4.612
5	5.207	5.393	5.579	5.764
6	6.248	6.471	6.694	6.917
7	7.289	7.550	7.810	8.070
8	8.331	8.628	8.926	9.223
9	9.372	9.707	10.041	10.376
10	10.413	10.785	11.157	11.529

Table for converting run-off in second-feet per square mile into depth in inches per month of 30 and 31 days.

Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.
	Inch.	*Inch.*		*Inch.*	*Inch.*		*Inch.*	*Inch.*		*Inch.*	*Inch.*
0.01	0.01	0.01	.60	.67	.69	1.19	1.33	1.37	1.78	1.99	2.05
.02	.02	.02	.61	.68	.70	1.20	1.34	1.38	1.79	2.00	2.06
.03	.03	.03	.62	.69	.71	1.21	1.35	1.39	1.80	2.01	2.07
.04	.04	.05	.63	.70	.73	1.22	1.36	1.41	1.81	2.02	2.08
.05	.06	.06	.64	.71	.74	1.23	1.37	1.42	1.82	2.03	2.09
.06	.07	.07	.65	.73	.75	1.24	1.38	1.43	1.83	2.04	2.11
.07	.08	.08	.66	.74	.76	1.25	1.39	1.44	1.84	2.05	2.12
.08	.09	.09	.67	.75	.77	1.26	1.41	1.45	1.85	2.06	2.13
.09	.10	.10	.68	.76	.78	1.27	1.42	1.46	1.86	2.08	2.14
.10	.11	.12	.69	.77	.80	1.28	1.43	1.48	1.87	2.09	2.16
.11	.12	.13	.70	.78	.81	1.29	1.44	1.49	1.88	2.10	2.17
.12	.13	.14	.71	.79	.82	1.30	1.45	1.50	1.89	2.11	2.18
.13	.15	.15	.72	.80	.83	1.31	1.46	1.51	1.90	2.12	2.19
.14	.16	.16	.73	.81	.84	1.32	1.47	1.52	1.91	2.13	2.20
.15	.17	.17	.74	.83	.85	1.33	1.48	1.53	1.92	2.14	2.21
.16	.18	.18	.75	.84	.86	1.34	1.50	1.54	1.93	2.15	2.22
.17	.19	.20	.76	.85	.88	1.35	1.51	1.56	1.94	2.16	2.23
.18	.20	.21	.77	.86	.89	1.36	1.52	1.57	1.95	2.18	2.25
.19	.21	.22	.78	.87	.90	1.37	1.53	1.58	1.96	2.19	2.26
.20	.22	.23	.79	.88	.91	1.38	1.54	1.59	1.97	2.20	2.27
.21	.23	.24	.80	.89	.92	1.39	1.55	1.60	1.98	2.21	2.28
.22	.25	.25	.81	.90	.93	1.40	1.56	1.61	1.99	2.22	2.29
.23	.26	.27	.82	.91	.95	1.41	1.57	1.63	2.00	2.23	2.31
.24	.27	.28	.83	.93	.96	1.42	1.58	1.64	2.01	2.24	2.32
.25	.28	.29	.84	.94	.97	1.43	1.60	1.65	2.02	2.25	2.33
.26	.29	.30	.85	.95	.98	1.44	1.61	1.66	2.03	2.26	2.34
.27	.30	.31	.86	.96	.99	1.45	1.62	1.67	2.04	2.28	2.35
.28	.31	.32	.87	.97	1.00	1.46	1.63	1.68	2.05	2.29	2.36
.29	.32	.33	.88	.98	1.01	1.47	1.64	1.69	2.06	2.30	2.38
.30	.33	.35	.89	.99	1.03	1.48	1.65	1.71	2.07	2.31	2.39
.31	.35	.36	.90	1.00	1.04	1.49	1.66	1.72	2.08	2.32	2.40
.32	.36	.37	.91	1.02	1.05	1.50	1.67	1.73	2.09	2.33	2.41
.33	.37	.38	.92	1.03	1.06	1.51	1.68	1.74	2.10	2.34	2.42
.34	.38	.39	.93	1.04	1.07	1.52	1.70	1.75	2.11	2.35	2.43
.35	.39	.40	.94	1.05	1.08	1.53	1.71	1.76	2.12	2.37	2.44
.36	.40	.42	.95	1.06	1.10	1.54	1.72	1.78	2.13	2.38	2.46
.37	.41	.43	.96	1.07	1.11	1.55	1.73	1.79	2.14	2.39	2.47
.38	.42	.44	.97	1.08	1.12	1.56	1.74	1.80	2.15	2.40	2.48
.39	.44	.45	.98	1.09	1.13	1.57	1.75	1.81	2.16	2.41	2.49
.40	.45	.46	.99	1.10	1.14	1.58	1.76	1.82	2.17	2.42	2.50
.41	.46	.47	1.00	1.12	1.15	1.59	1.77	1.83	2.18	2.43	2.51
.42	.47	.48	1.01	1.13	1.16	1.60	1.79	1.84	2.19	2.44	2.52
.43	.48	.50	1.02	1.14	1.18	1.61	1.80	1.86	2.20	2.45	2.54
.44	.49	.51	1.03	1.15	1.19	1.62	1.81	1.87	2.21	2.47	2.55
.45	.50	.52	1.04	1.16	1.20	1.63	1.82	1.88	2.22	2.48	2.56
.46	.51	.53	1.05	1.17	1.21	1.64	1.83	1.89	2.23	2.49	2.57
.47	.52	.54	1.06	1.18	1.22	1.65	1.84	1.90	2.24	2.50	2.58
.48	.54	.55	1.07	1.19	1.23	1.66	1.85	1.91	2.25	2.51	2.59
.49	.55	.56	1.08	1.20	1.25	1.67	1.86	1.93	2.26	2.52	2.60
.50	.56	.58	1.09	1.22	1.26	1.68	1.87	1.94	2.27	2.53	2.61
.51	.57	.59	1.10	1.23	1.27	1.69	1.89	1.95	2.28	2.54	2.62
.52	.58	.60	1.11	1.24	1.28	1.70	1.90	1.96	2.29	2.55	2.63
.53	.59	.61	1.12	1.25	1.29	1.71	1.91	1.97	2.30	2.57	2.64
.54	.60	.62	1.13	1.26	1.30	1.72	1.92	1.98	2.31	2.58	2.66
.55	.61	.63	1.14	1.27	1.31	1.73	1.93	1.99	2.32	2.59	2.67
.56	.62	.65	1.15	1.28	1.33	1.74	1.94	2.01	2.33	2.60	2.68
.57	.64	.66	1.16	1.29	1.34	1.75	1.95	2.02	2.34	2.61	2.69
.58	.65	.67	1.17	1.31	1.35	1.76	1.96	2.03	2.35	2.62	2.70
.59	.66	.68	1.18	1.32	1.36	1.77	1.97	2.04	2.36	2.63	2.72

Table for converting run-off in second-feet per square mile, etc.—Continued.

Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.	Second-feet per square mile.	30 days.	31 days.
	Inch.	*Inch.*		*Inch.*	*Inch.*		*Inch.*	*Inch.*		*Inch.*	*Inch.*
2.37	2.64	2.73	2.78	3.10	3.21	3.19	3.56	3.68	3.60	4.02	4.15
2.38	2.66	2.74	2.79	3.11	3.22	3.20	3.57	3.69	3.61	4.03	4.16
2.39	2.67	2.76	2.80	3.12	3.23	3.21	3.58	3.70	3.62	4.04	4.17
2.40	2.68	2.77	2.81	3.14	3.24	3.22	3.59	3.71	3.63	4.05	4.18
2.41	2.69	2.78	2.82	3.15	3.25	3.23	3.60	3.72	3.64	4.06	4.20
2.42	2.70	2.79	2.83	3.16	3.26	3.24	3.61	3.74	3.65	4.07	4.21
2.43	2.71	2.80	2.84	3.17	3.27	3.25	3.63	3.75	3.66	4.08	4.22
2.44	2.72	2.81	2.85	3.18	3.29	3.26	3.64	3.76	3.67	4.09	4.23
2.45	2.73	2.82	2.86	3.19	3.30	3.27	3.65	3.77	3.68	4.11	4.24
2.46	2.74	2.84	2.87	3.20	3.31	3.28	3.66	3.78	3.69	4.12	4.25
2.47	2.76	2.85	2.88	3.21	3.32	3.29	3.67	3.79	3.70	4.13	4.27
2.48	2.77	2.86	2.89	3.22	3.33	3.30	3.68	3.80	3.71	4.14	4.28
2.49	2.78	2.87	2.90	3.24	3.34	3.31	3.69	3.82	3.72	4.15	4.29
2.50	2.79	2.88	2.91	3.25	3.35	3.32	3.70	3.83	3.73	4.16	4.30
2.51	2.80	2.89	2.92	3.26	3.37	3.33	3.71	3.84	3.74	4.17	4.31
2.52	2.81	2.91	2.93	3.27	3.38	3.34	3.73	3.85	3.75	4.18	4.32
2.53	2.82	2.92	2.94	3.28	3.39	3.35	3.74	3.86	3.76	4.20	4.33
2.54	2.83	2.93	2.95	3.29	3.40	3.36	3.75	3.87	3.77	4.21	4.35
2.55	2.85	2.94	2.96	3.30	3.41	3.37	3.76	3.89	3.78	4.22	4.36
2.56	2.86	2.95	2.97	3.31	3.42	3.38	3.77	3.90	3.79	4.23	4.37
2.57	2.87	2.96	2.98	3.32	3.44	3.39	3.78	3.91	3.80	4.24	4.38
2.58	2.88	2.97	2.99	3.34	3.45	3.40	3.79	3.92	3.81	4.25	4.39
2.59	2.89	2.99	3.00	3.35	3.46	3.41	3.80	3.93	3.82	4.26	4.40
2.60	2.90	3.00	3.01	3.36	3.47	3.42	3.82	3.94	3.83	4.27	4.42
2.61	2.91	3.01	3.02	3.37	3.48	3.43	3.83	3.95	3.84	4.28	4.43
2.62	2.92	3.02	3.03	3.38	3.49	3.44	3.84	3.97	3.85	4.30	4.44
2.63	2.93	3.03	3.04	3.39	3.50	3.45	3.85	3.98	3.86	4.31	4.45
2.64	2.95	3.04	3.05	3.40	3.52	3.46	3.86	3.99	3.87	4.32	4.46
2.65	2.96	3.06	3.06	3.41	3.53	3.47	3.87	4.00	3.88	4.33	4.47
2.66	2.97	3.07	3.07	3.43	3.54	3.48	3.88	4.01	3.89	4.34	4.48
2.67	2.98	3.08	3.08	3.44	3.55	3.49	3.89	4.02	3.90	4.35	4.50
2.68	2.99	3.09	3.09	3.45	3.56	3.50	3.90	4.04	3.91	4.36	4.51
2.69	3.00	3.10	3.10	3.46	3.57	3.51	3.92	4.05	3.92	4.37	4.52
2.70	3.01	3.11	3.11	3.47	3.59	3.52	3.93	4.06	3.93	4.38	4.53
2.71	3.02	3.12	3.12	3.48	3.60	3.53	3.94	4.07	3.94	4.40	4.54
2.72	3.03	3.14	3.13	3.49	3.61	3.54	3.95	4.08	3.95	4.41	4.55
2.73	3.05	3.15	3.14	3.50	3.62	3.55	3.96	4.09	3.96	4.42	4.57
2.74	3.06	3.16	3.15	3.51	3.63	3.56	3.97	4.10	3.97	4.43	4.58
2.75	3.07	3.17	3.16	3.53	3.64	3.57	3.98	4.12	3.98	4.44	4.59
2.76	3.08	3.18	3.17	3.54	3.65	3.58	3.99	4.13	3.99	4.45	4.60
2.77	3.09	3.19	3.18	3.55	3.67	3.59	4.01	4.14	4.00	4.46	4.61

INSTRUCTIONS TO COMPUTERS.

GAGE HEIGHTS.

A careful inspection of tabulated gage heights frequently will reveal errors made in reading the rod or subsequently introduced by transcribing, which on the face of them are incongruities or physical impossibilities. For example, take the accompanying table of the low-water flow of Coosa River at Rome, Ga., during part of the month of October, 1899. An inspection will reveal at once that the gage height for October 11 is to be viewed with suspicion. Although a sudden rise of 1.30 feet in twenty-four hours might be expected, at this low stage of the river a drop of 1 foot in the next twenty-four hours would be a very improbable occurrence. Upon looking up the original record it will be found that the correct gage height for that day is 1 foot.

October, 1899.	
1	0.40
2	.30
3	.30
4	.30
5	.30
6	.50
7	.70
8	.70
9	.80
10	.60
11	1.90
12	.90
13	.70
14	.70
15	.60
16	.60

In working up gage heights and records of discharge measurements computers should always be on their guard for errors of this nature, although the data bear check marks or initials indicating revision. In cases of this kind the stage and locality of the river should be taken into

account, for a fluctuation similar to that just illustrated would be quite characteristic of the river at a higher stage, say during the spring-flood season; or, again, it would be entirely compatible with the erratic behavior of streams in the arid regions, as, for instance, Queen Creek, Ariz., at any season of the year. Many errors in gage reading are due to observers mistaking feet for tenths or tenths for hundredths. A careful scrutiny of the general behavior of the stream and the exercise of a little judgment will often be found fruitful in determining the true relations.

RATING TABLES.

Rating tables should be made in all respects complete. They should contain the discharges for the lowest as well as for the highest gage heights occurring during the period to which they are applicable. If the gage at a station has been read to tenths of a foot only, the discharge in the rating table should be given for every tenth, and where gage readings are carried out to hundredths of a foot the rating table should give values for each half tenth. In applying rating tables of the latter class the gage readings are mentally reduced to the nearest half tenths and the corresponding discharge values are taken from the rating table. This applies to all rivers and creeks, with the exception of small streams and canals the observations on which have been made with special care, in which cases the rating tables should be constructed to furnish values for single hundredths.

In constructing rating tables great stress is laid on the necessity of avoiding the occurrence of negative second differences. The increments of the differences between the discharges of successive increasing gage heights may vary from a given quantity down to zero, as in the case of a rating curve changing into a straight line, but in no instance should the values of these increments or second differences become negative, implying the occurrence of a reverse curve in any portion of a rating curve. Although theoretically not impossible, the occurrence of a reverse curve is only admissible under certain peculiar local conditions existing in the stream channel at or near the gaging station, conditions which are generally avoided in establishing stations.

AVERAGES, RUN-OFFS, ETC.

Great care should be exercised in obtaining the mean monthly flow in second-feet to divide the total for a month by *the actual number of days recorded in that month*, i. e., not necessarily by the total number of days in the month, 28, 29, 30, or 31, as the case may be, but by the number of days for which the gage heights are given. Omissions in gage readings, due to a variety of causes, give rise to frequent gaps in the records, and these should not escape the attention of the computer. From the monthly means or averages so obtained are com-

puted the run-off per square mile, the run-off, in inches, on the watershed, and the total number of acre-feet for the month. In case of fractional months or incomplete records the monthly average should be treated as the average for a full month whenever the character of the partial record is such as fairly to represent the flow of the river during the entire month.

Thus an incomplete record of flow for a month during the low-water season may in most cases, without appreciable error, be given the weight of a full record, and the average run-offs and acre-feet be treated accordingly. On the other hand, a gap of six days in the record for a high-water month may frequently mean the omission of a large flood, perhaps too large to be measured and recorded, and the amount of water discharged during those six days may have equaled the total discharge of the river for the remainder of the month. Considering the mean of such a record as the mean for the entire month would evidently introduce here an error of 100 per cent. In such a case the proper method of procedure is to compute the run-offs and acre-feet for the exact number of days recorded, and insert a footnote stating the number of days that they represent.

Again, four or five readings taken at intervals during a winter month, when the river is partly frozen and its flow practically devoid of material fluctuations, will be ample upon which to base general figures of run-offs and acre-feet. The mean in such a case, however, will not be the arithmetical mean of the four or five records available, but an approximation, in round numbers, to that arithmetical mean. Such a figure should always be accompanied by a footnote stating that it is approximate.

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WATER-SUPPLY

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UNITED STATES GEOLOGICAL SURVEY

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UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

PRELIMINARY LIST

OF

DEEP BORINGS IN THE UNITED STATES

PART I

(ALABAMA-MONTANA)

BY

N. H. DARTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., July 31, 1901.

SIR: I have the honor to transmit herewith a preliminary list of deep borings in the United States (400 feet or more in depth), by Mr. N. H. Darton, with the request that it be published in the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

PRELIMINARY LIST OF DEEP BORINGS IN THE UNITED STATES.

PART I.—ALABAMA-MONTANA.

By N. H. Darton.

INTRODUCTION.

The wells and borings reported in the paper are all more than 400 feet in depth. The information concerning them has been obtained partly from replies to circular letters sent to all parts of the United States and partly from geological reports and other published sources. Owing to the difficulty of obtaining replies to the circulars, to lack of knowledge on the part of correspondents, and to the incompleteness of published records, doubtless there are borings which have not been reported. In regions of oil and gas wells, where borings are numerous, the individual wells can not be listed here, but representative wells are given. References to logs or records of the wells, or extended descriptions of them, are given in footnotes, and after the list of wells in each State there is added a list of the principal publications relating to deep borings in that State.

The bearing of the information given in the columns of the lists probably is apparent, unless, perhaps, in the one headed "Height to which the water rises." In this column an entry such as "—45" indicates that the water rises to within 45 feet of the surface; "+45" indicates that it is a flowing well and has sufficient head to raise the water 45 feet above the surface in an open pipe 45 feet or more in height. The yield in gallons per minute usually is estimated. Depths and diameters often have been reported from memory, and different sources of publication sometimes give different figures. Most wells which are not stated to be "for oil," "for gas," "brine," "abandoned," etc., in the remarks column, or "not any" in the yield column, generally afford more or less water. Many of the gas and oil wells, active or abandoned, yield salt water.

ALABAMA.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Anniston	Calhoun	400-550	8	695	− 30	Several wells.
Armstrong	Macon	442				Good water.
Birmingham	Jefferson	550		70	− 30	
Bladen Springs	Choctaw	1,300			+ 70	Water salt; first flow at 200 feet, second flow at 600 feet.
Boguechitto	Dallas	±400		0¼		In sec. 8, T. 18, R. 8 E.
Do	do	460	6	75	+ 25	Temp., 68°.
Boligee.[1]	Greene	415			Flows.	Temp., 68°.
Do.[1]	do	420			Flows.	Temp., 66°.
Do.[1]	do	468			Flows.	Temp., 66¼°.
Do.[1]	do	522			Flows.	Temp., 70°.
Boligee (at Finche's ferry).[1]	do	560			Flows.	Temp., 71°.
Brantley	Crenshaw	600	4			Good flow; 2 wells.
Bughall	Bullock	920				Unsuccessful.
Burton Hill[1]	Greene	544				Temp., 70°.
Do.[1]	do	420				
Do.[1]	do	555				Temp., 75°.
Butler	Choctaw	660			− 30	
Cahaba[1]	Dallas	400				Temp., 73¼°.
Cahaba (on river)[1]	do	590	6	80	22	Temp., 70°.
Cahaba (5 miles below).[1]	do	560		[2] 250		Two wells.
Cahaba[1]	do	728		1,200		Temp., 77¼°.
Carpenter	Jackson	400				Unsuccessful.
Cullman	Cullman	700				City well.
Demopolis	Marengo	765	3	30	+ 20	Temp., 64°.
Do	do	735	4	15	+ 12	
Do	do	850	6¼	60	Flows.	
Do	do	800	3	Many.	+ 52	
Demopolis (3 miles south).	do	1,350		Many.	− 30	
Demopolis (4 miles northeast).	do	500		200	Flow.	Several wells.
Dothan	Henry	625	8		−150	
Epes	Sumter	700		3	+ 1¼	
Eutaw[1]	Greene	743			− 10	
Eutaw (10 miles southwest).[1]	do	440-550				Temp., 71°-72¼°; four wells.
Faunsdale	Marengo	700		8	+ 2¼	
Fayette	Fayette	500			− 30	
Fitzpatrick	Bullock	900	6		− 30	
Do	do	1,300	6	12	− 30	
Florence	Lauderdale	+400				For gas; unsuccessful.
Forkland	Greene	575		20	+ 3	
Fort Morgan		700				
Greensboro	Hale	400-800		Many.	− 30	Several wells; good water.
Do	do					
Do	do	1,600				
Greensboro (10 miles southwest).	do	450 or 850?	12	Many.		
Greenville	Butler	±400	10-8	100	− 30	Two wells.
Guntersville	Marshall	1,006	8-6			Temp., 60°.
Hairston	Greene	530		4	+ 2¼	2¼ miles east.
Hanover (?)	Coosa	480	4		− 40	
Harris	Barbour	700				
Do	do	780	3			Abandoned; milky water at 140 feet to −15 feet.
Hartsell[3]	Morgan	1,730	2			1 mile north of town: salt water at 352 and 1,730 feet; gas at 602 and 1,094 feet; sulphur water at 160 feet.
Hatchechubbee	Russell	420		8	No flow.	Small supply of water at 250 feet.
Hunters Field	Dallas	550	5	70	− 18	
Hurtsboro	Russell	530	4	±10	− 9	
Do	do	550	3	±11	− 9	
Do	do	565	3	±12	− 23	
Jennings (3 miles southeast).[4]	Lawrence	5,120	6			Gas, oil, and salt water.

[1] Record, Am. Assoc. Adv. Science, Proc., vol. 10, p. 95.
[2] Each.
[3] Alabama Geol. Surv., Report on Valley Regions, Part 1, pp. 62-63.
[4] Ibid., pp. 61-62.

ALABAMA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Laneville	Hale	710			Flow.	Temp., 75°.
Do	do	719			Flow.	Temp., 76°.
Do	do	750				In progress.
Larkinsville	Jackson	400				Unsuccessful.
Linden	Marengo	1,193		1	Flows	Water at 1,040 to 1,115 feet.
Mobile	Mobile	700	6	400		Temp., 76°.
Do	do	735		Many.	+ 90	Temp., 78°.
Do	do	800	6	500		Temp., 76°.
Do	do	800	6	1,000	+ 70	Temp., 78°.
Do	do	850				
Montgomery	Montgomery	650–450	6	974–200	− 60	Four wells; originally flowed to +20 feet.
Newbern	Hale	475		30	+ 4	
Newmarket [1]	Madison	965	2		Flows.	
Oneonto	Blount	600				
Roba	Macon	450				Good water supply.
Russellville	Franklin	+1,350				2 miles east; unsuccessful.
Saint Elmo	Mobile	550				
Selma [2]	Dallas	409		230		Temp., 67½°.
Do	do	470	6			Temp., 72°.
Do	do	600	6	80	+ 16	Do.
Do	do	487	6	110	+ 28	Temp., 68°.
Do	do	650		100	+ 40	Four wells.
Sledges		490	4	Many.	− 60	
Sprague Junction	Montgomery	400	8–6		− 75	
Stewart	Hale	600			+ 8	
Tank Station	Dallas	560	6	90	+ 35	Temp., 70°.
Town Creek [3]	Lawrence	515				Abandoned.
Troy	Pike	2,700				Unsuccessful.
Tuskegee	Macon	500	6			Do.
Do	do	760	8			Do.
Union Springs	Bullock	1,000		Many.		
Do	do	848¼	6–2¼	60		
Do	do	848¼	8	150	−240	
Do	do	569		Many.		Good water.
Do	do	750		Many.		Do.
Uniontown	Perry	895	8		−125	
Do	do	1,195	8	300	−120	Water from 870 feet.

ARIZONA.

Ash Fork	Yavapai	1,025	10	No water.		In volcanic rock.
Aubrey	do	936	12–8	No water.		
Drake	Mohave	488	10			In progress.
Florence	Pinal	413	6	Few.		Well never used.
Gila Bend	Maricopa	1,300			−700	
Haviland	Mohave	600	10	Many.		
Kingman	Mohave	900 1,100		No water.		60 miles north.
Mohawk	Yuma	1,100	5¼–4¼			3 wells.
Do	do	500		28		
Phoenix	Maricopa	750	5		− 20	Abandoned.
Do	do	475				
Do	do	1,420				
Do	do	1,475				
Phoenix (12 miles west.)	do	500				Not completed.
Pima	Graham	420				Unsuccessful.
Safford	do	500			No flow.	
Sentinel	Maricopa	1,029	5	50	−185	
Thatcher	Graham	430		Few.	No flow.	
Wickenburg, northwest of.	Maricopa	400				No good results.
Winslow	Navajo	1,700				No fresh water.
Yucca	Mohave	534			−325	Satisfactory water supply.

[1] Record, Alabama Geol. Surv., Report on Valley Regions, Part 1, p. 127.
[2] Record, Am. Assoc. Adv. Science, Proc., vol. 10, pp. 97–98.
[3] Record, Pa. 2d Geol. Surv., Report II, p. 283.

ARKANSAS.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Arkansas City	Desha	552	6	Many.		Temp., 72°.
Bowen	Pike	400		Many.	No flow.	Several wells of this kind in county.
Fayetteville[1]	Washington	1,480				
Forrest City	St. Francis	465	4	Many.		
Do	do	465	6	Many.		
Gentry	Benton	492	8-6¼	420	− 19	
Do	do	±700			No flow.	
Do	do	1,000	7		− 30	Water at 700 and 900 feet.
Do	do	±1,350				
Helena	Phillips	500	12	Many.		Two wells.
Hope	Hempstead	500			− 60	
Hot Springs	Garland	860	6	13		
Hudson	Little River	900				
Do	do	800	4	Many.	No flow.	
Huntington	Sebastian	501	5¼		− 60	Water from 169 feet.
Monticello	Drew	500	8		−125	
Do	do	604	8-4¼	100	−110	
Mena	Polk	+700	10	Many.	No flow.	
Magazine	Logan	1,800				
Pine Bluff	Jefferson	915	8	521	− 30	Two wells.
Do	do	840	10	185	− 20	
Prescott (12 miles south).	Nevada	400-450			Flow.	Several wells.
Saline Landing[2]	Howard	466				
Texarkana	Miller	937	6	209	To surface.	
Washington	Hempstead	750	3		− 35	Weak vein of water at 104 feet.
Wilmer	Drew	400				
White Cliffs	Sevier	460			+ 25	
Do	do	450			+ 8	Temp., 65°.
Do	do	540			− 60	Temp., 64°.

CALIFORNIA.

Adams Canyon[3]	Ventura	400-2,780				Many oil wells, yielding 900 barrels per month.
Alameda	Alameda	489			Surface.	
Do.[4]	do	409			− 8	
Alhambra	Los Angeles	400	7			Oil well.
Alila[5]	Tulare	1,328	9		+ .25	Small flow of gas.
Aliso Canyon	Ventura	600-700				Several oil wells.
Arcade	Sacramento	2,100				
Atwater	Merced	400	7	5		
Auburn	Placer	730				
Alviso	Santa Clara	496	7		+ .5	
Do	do	740	7		+1.2	
Do	do	550	7		Flows.	
Bakersfield	Kern	480	8	30	Flows.	
Do	do	500	8	300	Flows.	
Do	do	1,100		480	Flows.	
Do	do	600	8	30	Flows.	
Do	do	400	8	1,500	Flows.	
Beckwith	Plumas	400	3	80	Flows.	
Do	do	500-800	3	100	Flow.	Numerous wells.
Do	do	1,000-1,200	2-3	Many.	Flow.	
Beckwith (8 miles above).	do	900	3	Many.		Very warm mineral water.
Bieber	Lassen	740	4			
Bishop	Inyo	420				In progress.
Brownstone	Ventura	400-800				Several wells.
Buckhorn Station (4 miles north).		400				Oil well.
Buena Vista	Kern	410				Oil at 392 feet.
Carpinteria (2 miles from).[6]	Santa Barbara.	700				Oil and gas well.

[1] Record, Arkansas Geol. Surv., Report, vol. 2, 1891, pp. 67-69.
[2] Id., vol. 1, 1891, p. 105.
[3] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, pp. 35-36.
[4] Record, Cal. State Mining Bureau, 11th Rept., 1891-92, pp. 135-136.
[5] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 488.
[6] Id., 12th Rept., 1893-94, p. 357.

CALIFORNIA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Cedarville	Modoc	433			No flow.	
Centerville	Alameda	442			Flows.	
Chico	Butte	686		Several	No flow.	
Chino (about 2½ miles northwest).	San Bernardino.	600				Abandoned.
Chittenden	Santa Cruz	800				For oil.
Clearwater (?)	Los Angeles	465		Many.		
Coalinga[1]	Fresno	400-650				Numerous oil wells in two groups, one 3 miles west, the other 9 miles north.
Crows Landing	Stanislaus	408	8	2	Flows(?)	
Cutler Salmon Ranch	San Joaquin	1,250	7-4			Gas well.
Danby	San Bernardino.	630	10	50	−200	
Delano	Kern	713	15	3,470	Flows.	
Delano (5 miles southwest).	do	822			− 3	
Dos Palos	Merced	442-550				Several wells.
Downey	Los Angeles	412	2	60		
Eagleville	Modoc	503	4½			
El Verano[2]	Sonoma	544			No flow.	
Embarcadero[3]	do	405			+ 15	
Ethel		442	10	Many.	To surface.	
Fairview	Orange	450	7			
Fenner	San Bernardino.	800	10	Many.	−200	
Fitchburg[4]	Alameda	400-500	7-12	1,000	No flow.	Several wells.
Flowing Well	San Diego	±400				
Four Forks[5]	Ventura	700-1,100				Several oil wells.
Fresno	Fresno	575				
Garvanza (west of)	Los Angeles	985				For oil; unsuccessful.
Glendora	do	2,038	5½		No flow.	
Grafton	Yolo	450	6	Many.		
Grangeville	Tulare	980	7		−.10	
Hanford[6]	Kings	500-800	9-7	100-400	Flow.	Numerous wells.
Do	do	1,300				
Irvington	Alameda	450			Flows.	
J. G. James' ranch	Fresno	600-800	7-8	Flows.	+ 3	Several wells. Temp., 60°.
Kentuck	Ventura	700-730				Several oil wells.
Kingsburg	Fresno	600			No flow.	
Lathrop Junction	San Joaquin	1,420	8		Flows.	Gas well.
Limekiln Canyon	Tulare (?)	500				Oil well.
Little Sespe District	Ventura	805				Do.
Long Beach	Los Angeles	500	8	1,100	Flows.	
Do	do	460	9-7	Many.	Flows.	
Los Angeles[7]	do	450-1,300				Numerous oil wells, some abandoned.
Los Angeles (The Ivanhoe).[8]	do	+1,000				Small supply of oil, abandoned.
Los Angeles (United States Hotel).[9]	do	+ 900				Gas at 900 feet.
Los Angeles (Stewart and McFarland).[10]	do	1,485				For oil; unsuccessful.
Los Angeles (Angelina Heights).[11]	do	1,186				For oil or gas; abandoned.
Los Angeles (Boyle Heights).	do	600				For oil; unsuccessful.
Los Angeles (Dr. Long's ranch).	do	500	7			Small supply of oil; abandoned.
Los Angeles (Lookout Mountain).	do	550				Do.
Los Angeles (few miles southeast).	do					Gas well.
Los Angeles (4 miles northwest).[12]	do	820				Small supply of oil.

[1] Analysis, Cal. State Mining Bureau, 12th Rept., 1893-94, pp. 352-353.
[2] Record, Cal. State Mining Bureau, 11th Rept., 1891-92, p. 457.
[3] Record, ibid., p. 457.
[4] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 134.
[5] Id., Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, p. 27.
[6] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 489.
[7] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, pp. 14-17.
[8] Ibid., p. 14.
[9] Ibid., p. 17.
[10] Cal. State Mining Bureau, 7th Rept., 1887, p. 78.
[11] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, p. 14.
[12] Cal. State Mining Bureau, 7th Rept., 1887, p. 77.

CALIFORNIA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Los Angeles (5¼ miles west).[1]	Los Angeles	± 500				Small flow of gas: abandoned.
Los Angeles (6 miles west).[1]	do	658-1,485				Two wells, for oil; unsuccessful.
Los Angeles (10 miles north of west).[2]	do	520				Two wells, sulphur water and some gas; abandoned.
Los Banos[3]	Merced	434			Flows.	
Loyalton	Sierra	525-750	4	50	Flow.	Several wells.
Do	do	1,000		20	Flows.	Temp. 130°.
Do	do	400	3	100	Flows.	
Do	do	620	4		Flows.	
Do	do	430-512	3	30	Flow.	Several wells.
Ludlow	San Bernardino.	1,800		Few.		Not in use.
Madera[4]	Madera	1,200			−3	
Do	do	680			+ 1/16	
Madera (6 miles west)	do	633	7	¾	Flows.	
Mayfield	Santa Clara	604	7	100	Flows.?	
Merced	Merced	600-700	9	167-175		
Merced (13 miles southwest).	do	1,013	10		+ 1¼	Strongest flow at 665 and 680 feet.
Milpitas	Santa Clara	500-700	7		+ 2	Two wells.
Miramonte	Kern	636	8	1,670	Flows.	
Do	do	457	8			
Modesto (1 mile east)	Stanislaus	1,070		Many.	No flow.	Small flow of gas.
Montague[5]	Siskiyou	1,300	10-8			Gas well.
Moody Gulch[6]	Santa Barbara.	1,400				For oil or gas.
Mount Cayetana (southwest slope, near Santa Paula Creek).[7]	Ventura	430-1,170				Several oil wells.
Mount Diablo	Santa Barbara.	900				
Newman	Stanislaus	427	12		Flows.	
Do	do	445	8	1,250		
Newman Ranch	do	411	8		4¼	Brackish water.
Nordhoff (1 mile south).	Ventura	500-800				Several oil wells.
Norman (2 miles north).[8]	Glenn	940	2	4	+15	Small amount of gas at 337 feet.
Norman (about ¼ mile southeast).	do	1,100			Surface.	Small amount of gas at 500 feet.
North Cucamonga	San Bernardino.	450		Many.		
Norwalk	Los Angeles	480	4			
Oakland	Almeda	506		112	Flows.	
Ontario	do	457	9¼		No flow.	
Oroville	Butte	800	3	4	Flows.?	
Pasadena	Los Angeles	1,200				No water.
Peru (1½ miles south)	Ventura	400-570				Several oil wells.
Pico	Los Angeles	600-735				Numerous oil wells
Pixley	Tulare	438	8	Many.		
Do	do	480	7	Many.	+ .1	
Do	do	600	8		+ .8	
Do	do	713	9		+ .3	
Do	do	730	8		+ .2	
Pixley (1½ miles northwest).[9]	do	955	9		+ .2	
Pixley (2 miles east)	do	600	8		.1	
Pixley (vicinity)	do	1,150	9	1,200	Flows.	
Do	do	937	9		+ .2	
Pixley (3 miles west)	do	858	8		+ .7	
Pixley	do	1,060	9		Flows.	
Pixley (3 miles southwest).	do	815	9		+ .2	
Pixley (6 miles southwest).[10]	do	1,150	9		+ 1	
Pixley (6 miles west)	do	950	8		+ .7	

[1] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, p. 15.
[2] Cal. State Mining Bureau, 7th Rept., 1887, p. 78.
[3] Record, Cal. State Mining Bureau, 10th Rept., 1890, p. 326.
[4] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 211.
[5] Cal. State Mining Bureau, 12th Rept., 1893-94, p. 351.
[6] Record, Cal. State Mining Bureau, 8th Rept., 1888, p. 548.
[7] Record, Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, pp. 37-38.
[8] Record, Cal. State Mining Bureau, 11th Rept., 1891-92, p. 224.
[9] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 487.
[10] Ibid., pp. 487-488.

CALIFORNIA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Pixley (10 miles southwest).[1]	Tulare	895	10		+.4	
Pomona	do	450-550	6 and 9			
Potter Valley	Mendocino	400			−11	
Puente[2]	Los Angeles	100-1,750				Numerous oil wells.
Roberts Island	San Joaquin	1,435	7-5		Flows.	Gas well; saline water.
Riverside	Riverside	580	10	Many.	Flows.	
Rocky Point	Sierra	1,132	3	20	Flows.	
Do	do	1,040	4	10	Flows.	
Sacramento[3]	Sacramento	876				Gas well.
Do.[4]	do	965				Do.
Do.[4]	do	970			Flows.	Water salty and alkaline.
Sacramento (9 miles northeast).[5]	do	2,250			Flows.	Some gas.
St. Helena	Napa	2,000				
Salinas	Monterey	1,435	8		− 6	
Do	do	1,100	11-9		−10	
Salt Marsh Canyon[6]	Ventura	400-1,600				Several oil wells.
San Bernardino	San Bernardino.	605	6	Many.	Flows.	
Do	do	425	3	76	Flows.	
Do	do	415	3	7	Flows.	
San Francisco	San Francisco	865	8-5	87		
San Gabriel	Los Angeles	500±	7			
San Jacinto	San Diego	456-650	7			Several wells.
San Jose	Santa Clara	442-700	7	Many.	Flow.	Do.
Do	do	400	8	900	Flows.	
San Lewis Ranch	Merced	410-426	7	128-160		Two wells.
San Louis Obispo	San Louis Obispo.	928		Many.	Flows.	For oil; unsuccessful. Sulphur water; temp., 103°; gas at 600 feet.
Santa Barbara (7 miles east).[7]	Santa Barbara.	400-1,000				Several oil wells; some abandoned.
Santa Clara	Santa Clara	600		Many.	+10	Temp., 60°.
Santa Paula region	Ventura	530-800				Several oil wells.
Santa Rosa (4 miles south).[8]	Sonoma	815		Few.		Flows at intervals.
Sattley	Sierra	625	2	1	Flows.	
Savilla Colony[9]		600		Many.	Flows.	Gas and sulphur water; gas not used.
Semitropic	Kern	495	8-7	Many.	Flows.	
Sheridan[10]	Placer	734			−19	
Sierra Valley	Sierra	640-888	3	15-45	Flow.	Several wells.
Do	do	556-900	4	125-300	Flow.	Do.
Do	do	746	2	16	Flows.	
Silverthread oil district (near Santa Paula Creek).[11]	Ventura	400-1,600				Numerous oil wells.
Sisi Canyon		400-800				Do.
Smyrna Colony	Kern	524-600				Two wells.
Stockton	San Joaquin	420	8		+ ¼	Warm water.
Stockton (S. F. and S. J. V. R. R.)	do	497	7	Many.	−19	
Stockton[12]	do	1,002			+ 7	Temp., 77°.
Do	do	1,400-2,000				Gas wells.
Stockton (Jackson well).[13]	do	1,700	12-9¼	Many.		Gas well.
Stockton[14]	do	1,400				Do.

[1] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 488.
[2] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, pp. 18-21.
[3] Cal. State Mining Bureau, 12th Rept., 1893-94, p. 350.
[4] Ibid., p. 350.
[5] Record, Cal. State Mining Bureau, 10th Rept., 1890, p. 505.
[6] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, pp. 36-37.
[7] Cal. State Mining Bureau, 12th Rept., 1893-94, p. 357.
[8] Record, Cal. State Mining Bureau, 11th Rept., 1891-92, p. 456.
[9] Cal. State Mining Bureau, Bull. No. 3, Gas and Petroleum Yielding Formations of the Central Valley of California, p. 20.
[10] Record, Cal. State Mining Bureau, 11th Rept, 1891-92, p. 319.
[11] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, pp. 33, 35, 37.
[12] Record, Cal. State Mining Bureau, 8th Report, 1888, pp. 559-560.
[13] Record, Cal. State Mining Bureau, Bull. No. 3, Gas and Petroleum Formations of the Central Valley of California, p. 17.
[14] Ibid., p. 17.

CALIFORNIA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Stockton Asylum (Jackson well).[1]	San Joaquin	600+-1,750		Many.		Two gas wells.
Stockton (St. Agnes College).[1]	do	1,720		Many.		Do.
Stockton (courthouse).[2]	do	1,917	12-8	Many.		Gas well.
Stockton (Citizens' Gas Co.).	do	2,061		Many.		Do.
Stockton	do	980-1,080		Many.	Flow.	Several wells; temp., 75°.
Stockton (9 miles southeast).	do	1,404	7-5	Many.		Some gas.
Summit	Plumas	400-800	3	5-125	Flow.	Numerous wells.
Do	do	1,008	3-4		Flow.	
Sunset District[3]	Kern	500-1,350				Numerous oil and brine wells.
Susanville	Lassen	960			-10	
Tar Creek[4]	Ventura	700-1,000				Numerous oil wells.
Tar Creek Canyon	do	400-905				Do.
Tipton	Tulare	400	7		+.04	Several wells about the same depth.
Do	do	480	8-6		+.04	
Do	do	503-1,012	8-9	Many.	Flow.	Several wells.
Torrey Canyon	Ventura	450-1,000		Many.	Flow.	Oil wells.
Traver	Tulare	960	7	Few		
Tulare	do	400	6		+.8	
Do	do	460	7	500		
Tulare (about 20 miles west).	do	500	7		+.15	Several wells about this depth.
Tulare (E. Jacob's Ranch).	do	539	9		+.1	Some gas.
Do[5]	do	498	9		+.1	Do.
Do[6]	do	887	9		+.35	Gas well.
Do	do	835	9		+.3	
Tulare (city wells)	do	552	9	Many.	-15	Several wells.
Tulare	do	720	8	300	Flows.	Several wells about this depth.
Tulare (about 20 miles southwest; Lambertson Ranch).[7]	do	1,058	9	Many.	+.75	Gas at 600 and 700 feet.
Tulare (7 miles west)[8]	do	730	8		+.35	
Vinton	Plumas	700		150	Flows.	
Visalia	Tulare	775	7	190	Flows.	
Watsonville	Santa Clara	540			— 2	
Waukena	Tulare	450-816	8-9	Many.	Flow.	Several wells.
Wheeler Canyon[9]	Ventura	400-900				Do.
Wild Bill Gulch[10]	do	850-975				Oil wells.
Winchester	Riverside	400				
Yreka	Siskiyou	700	4½	135	+32	

[1] Record, Cal. State Mining Bureau, Bull. No. 3, Gas and Petroleum Formations of the Central Valley of California, p. 18.
[2] Record, ibid., pp. 15-16.
[3] Cal. State Mining Bureau, 12th Rept., 1893-94, pp. 353-354; Record, Cal. State Mining Bureau, Bull. No. 3, Gas and Petroleum Yielding Formations of the Central Valley of Cal., p. 30.
[4] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, p. 27.
[5] Cal. State Mining Bureau, 11th Rept., 1891-92, p. 489.
[6] Ibid., pp. 488-489.
[7] Ibid., p. 488.
[8] Ibid., p. 487.
[9] Cal. State Mining Bureau, Bull. No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, p. 37.
[10] Ibid., p. 36.

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California State Mining Bureau, Seventh Annual Report of the State Mineralogist for the year ending October 1, 1887, 315 pages, Sacramento, 1888.

California State Mining Bureau, Annual Report of the State Mineralogist for the year ending October 1, 1888, 948 pages, plates, Sacramento, 1888.

California State Mining Bureau, Tenth Annual Report of the State Mineralogist for the year ending December 1, 1890, 983 pages, plates, Sacramento, 1890.

California State Mining Bureau, Eleventh Report of the State Mineralogist (first biennial), two years ending September 15, 1892, 612 pages, Sacramento, 1893.

California State Mining Bureau, Twelfth Report of the State Mineralogist (second biennial), two years ending September 15, 1894, 541 pages, Sacramento, 1894.

California State Mining Bureau, Bulletin No. 3, the Gas and Petroleum Yielding Formations of the Central Valley of California, by W. L. Watts, 99 pages, plates and maps, Sacramento, 1894.

California State Mining Bureau, Bulletin No. 11, Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties, part 1, by W. L. Watts, 94 pages, plates, map, Sacramento, 1897.

COLORADO.

Location.		Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
Town.	County.					
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Acequia	Douglas	442		15	Flows.	
Do	do	596		4	Flows.	
Akron	Washington	1,260				Failure; abandoned.
Alamosa	Conejos	505	3	3	Flows.	
Do	do	604	3	225	Flows.	
Do.[1]	do	856	6-8	1,000	Flows.	Temp., 65°.
Do	do	465	3¼	Many.	Flows.	
Do	do	474	2	Many.	Flows.	
Do	do	1,000	7¼-6	Many.	Flows.	Temp., 75°.
Do	do	900	8	Many.	Flows.	2 wells; temp., 70°.
Arvada	Jefferson	460			Flows.	
Artesian	Arapahoe	700		Very few.	Flows.	
Do	do	565		20	Flows.	
Do	do	720		10	+ 35	
Boulder	Boulder	400	2	5	Flows.	
Do	do	+1,000			+ 20	Water too "alkaline."
Boulder (4 miles east)	do	600				Unsuccessful.
Bonita	Arapahoe	725	3	80	Flows.	
Brighton	do	406	3	30	+ 15	
Do	do	700		Few.	Flows.	
Do	do	500				
Burlington	Kit Carson	600		Small.	Flows.	
Byers	Arapahoe	450	2	1¼		
Calhan[2]	El Paso	566	6			Saline water.
Canon City	Fremont	1,600		700	+100	Temp., 90°.
Canon City (near)	do	1,278	4¼	1/10	— 15	Water at 350 feet.
Cheyenne Wells[3]	Cheyenne	1,770				For water. Abandoned.
Do	do	1,702				For gas. Failure.
Colfax	Custer	627		7	Flows.	
Colorado City	El Paso	2,020				Gas. Pressure 155 pounds to square inch. Now filled with surface water.
Do	do	1,300				Gas at 216 feet. Shut off by water. (Blue shale below 35 feet.)
Colorado Springs	do	1,120				
Cotton Creek	Saguache	405	3	75	Flows.	Temp., 58°.
Cortez[4]	Montezuma	795		Several	No flow.	
Crestone	Saguache	426	3	10	Flows.	
Do	do	446	3	75	Flows.	
Del Norte	Rio Grande	607			Flows.	
Delta	Delta	575	2¼	Few.	Flows.	
Do	do	580	3		Flows.	
Denver[5]	Arapahoe	350	2¼	¼	+ 6	Temp., 56°.
Do	do	407	3-2	30	+ 25	Temp., 62°.
Do	do	444		50		
Do	do	500	3	40	+ 60	Temp., 50°.

[1] Record, 51st Congress, 1st session, Senate Ex. Doc., No. 222, p. 223, Washington, 1890.
[2] Record, 51st Congress, 1st Session, Senate Ex. Doc., No 222, p. 216, Washington, 1890.
[3] Record, U. S. Geol. Surv., 16th Ann. Rep., 1894-95. Part II. p. 563, Washington, 1895.
[4] Record, Colorado State Engineer, 8th Annual Report for 1895-96, pp. 69 70.
[5] In Denver and vicinity there are several hundred wells, mainly from 350 to 1,000 feet deep. They yield flows of considerable size from several horizons, but owing to large number of wells the volume of water is now greatly decreased. The wells are described in the following publications: 51st Congress, 1st session, Senate Ex. Doc. No. 222, pp. 175 205, 227-228, Washington, 1890; Monograph, U. S. Geol. Surv., Vol. XXVII, Geology of the Denver Basin, by S. F. Emmons, W. Cross, and G. H. Eldridge, 4°, Washington, 1896.

COLORADO—Continued.

Location. Town.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Denver	Arapahoe	575	9-6¼	Small.	No flow.	
Do	do	604	3-4			
Do	do	625	4	60	+ 60	
Do	do	720	3¼	10	+ 35	
Do	do	725	3	70	+ 40	
Do	do	810	4	70	− 5	Flow pumped down.
Do	do	856	3¼-2¼	10	+ 20	
Do	do	908	2¼		− 24	
Do	do	1,069	5			
Do	do	1,103			No flow.	
Do	do	1,250				Drilled for oil. Salt water to —40. Well abandoned.
Durango	La Plata	400			Flows.	
Eaton	Weld	970			No flow.	Much water at 230-260 feet. Some water at 400 and 625 feet.
Evans	do	1,200		Few.	Flows.	Water from 1,125 ft.
Fleming	Logan	423			−160	Very small supply of water.
Florence[1]	Fremont	780		1	Flows.	Numerous oil wells in vicinity.
Do	do	+1,000		700	Flows.	Water at 1,000 feet.
Do	do	+ 800		1,000	Flows.	Temp., 86°.
Fort Logan	Arapahoe	685			No flow.	
Do	do	558	4		No flow.	
Fort Lupton	Weld	904			− 4	
Fort Lyon	Bent	815				Abandoned. Small amount of water at 430 feet.
Franceville Junction	El Paso	Many.				
Georgetown	Clear Creek	658	2	120	100	
Grand Junction	Mesa	1,000	6¼-5¼	Few.	No flow.	Some gas at 444, 710, and 864 feet.
Greeley[2]	Weld	446	2¼	¼	No flow.	
Do	do	970	4		− 20	
Do	do	1,165		40	Flowed at first.	Several wells.
Do	do.[3]	2,140	8-4	Few.	− 40	Water from 1,165-1,200 feet.
Hoehne	Las Animas	938				Well abandoned.
Hygiene[4]	Boulder	965				Flowed at 675 feet.
Irondale	Arapahoe	500	6-4	60	Flows.	
Iron Springs	Otero	1,006			—556	Flows at 240 and [illegible] feet; unsatisfactory water at 1,[illegible] feet. In progress.
Island Station	Arapahoe	440	8	60	Flows.	
Do[5]	do	430	4	15	+ 40	
Do	do	730			—125	
Kit Carson	Cheyenne	1,460				No fresh water; salt water at 450 feet.
Lajunta[6]	Otero	412	4¼	8	Flows.	Temp., 68°.
Do	do	420	8-6	45	Flows.	2 wells; temp., 70°.
Do	do	439	6			Temp., 68°.
Do	do	640	5¼	85	Flows.	Temp., 68°.
Do	do	670	8¼	15	Flows.	
Do	do	700	6			Do.
Do	do	740	7¼	12¼	Flows.	Temp., 75°.
Do	do	766	7¼	25		Temp., 68°.
Do	do	1,152	5¼	Many.	Flows.	
Lamar[7]	Prowers	560	5¼	5	Flows.	Can pump 80 gals.
Lamar (northwest of).	do	420			No flow.	
Langford (4 miles northeast).	Boulder	400	2	3	Flows.	
Larkspur	Douglas	560				
Las Animas	Bent	+570		82		
Las Animas (7 miles northeast).	do					See Fort Lyon.

[1] Record, 51st Congress, 1st session, Senate Ex. Doc. No. 222, p. 214, Washington, 1890.
[2] Fifty-first Congress, 1st session, Senate Ex. Doc. No. 222, pp. 209-210, Washington, 1890.
[3] Analysis, ibid., p. 226.
[4] Record, ibid., p. 208.
[5] Fifty-first Congress, 1st session, Senate Ex. Doc. No. 222, p. 197, Washington, 1890.
[6] Record, Colorado State Engineer, Ninth Biennial Report, for 1897-98, pp. 28-29.
[7] Record, Colorado State Engineer, Ninth Biennial Report for 1897-98, p. 29; analysis, 51st Congress, 1st session, Ex. Doc. No. 222, p. 228, Washington, 1890.

COLORADO—Continued.

Location. Town.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Leadville	Lake	400		30		
Littleton	Arapahoe	467	3¼	20		2 other similar wells, 440 and 480 feet.
Do	do	500	3¼-2¼	16		
Do	do	510		25	+ 35	
Do	do	525		9	Flow.	Temp., 62°. Several similar wells from 520 to 560 feet deep.
Do	do	580		8	Flow.	
Do	do	601		15	+ 16	Several similar wells from 600 to 675 feet deep.
Do	do	710		45		Several similar wells from 700 to 735 feet deep.
Do	do	810		+1		
Do	do	1,300	8-4	3¼	+ 50	
Lockett	Saguache	418	3		+ 11	
Longmont	Boulder	431	4	+2		
Do	do	506			No flow.	
Do	do	600	6	40	+ 30	
Do	do	640	3¼	Few.		
Loveland[1]	Laramie	2,465		1	Flowed.	Water at 1,365 feet.
Lyman	Arapahoe	620		10		
Manzanola	Otero	1,113	5¼	42	Flows.	Temp., 80°.
Moffat	Saguache	404	3	Few.	Flows.	
Do	do	650			Flows.	
Do	do	710	2		+ 1¼	
Montrose	Montrose	825		30	Flow.	Temp., 72°.
Mosca	Costilla	610	4¼		+ 3	
Do	do	420	4		Flow.	
Ordway	Otero	1,575	4¼	Many.	—250	Temp., 63°.
Otis[2]	Washington	2,400		None.		Abandoned.
Petersburg	Arapahoe	600		20	+ 35	
Do.[3]	do	720	3¼-2¼	10	+ 35	
Pueblo[4]	Pueblo	772	4¼	2¼	Flows.	
Do	do	782		3-5	Flows.	
Do	do	789	5¼	300	Flows.	
Do	do	1,150		3	Flows.	
Do	do	1,219	4¼	20	+125	Temp., 76°.
Do	do	1,260		20-25	Flows.	
Do	do	1,400	3	¼	+140	Temp., 77°.
Do	do	1,402		+ 87	+140	
Rocky Ford	Otero	767	5¼	130	Flows.	Temp., 78°.
Do	do	790	10-4¼	68	+ 75	Temp., 74°.
Do	do	793	7¼	68	Flows.	Temp., 78°.
Do	do	820	7¼	38	Flows.	Temp., 75°.
Do.[5]	do	845	4	115	Flows.	Temp., 72°.
Do	do	1,033	6	17	Flows.	Temp., 75°.
Rouse Junction	Huerfano	2,058		Few.	—200	Salt water at 890 feet, small amounts of water at 700 and 1,600 feet.
Saguache	Saguache	400	4¼			
Salt Creek	Pueblo	2,030			No flow.	Small amount of water at various depths. Abandoned.
Scranton[6]	Arapahoe	800¼	3			Coal prospect. No water.
Sedalia	Douglas	650	2¼			
Do	do	710			No flow.	
Do	do	1,440				Water from 200 to 300 feet only.
Sedalia (5 miles south.)[6]	do					
Sheridan	Arapahoe	580		20		
Do	do	620		10		
Sheridan Lake	Kiowa	1,280	6		—280	Water at 1,200 feet. Abandoned.
Stout[7]	Larimer	1,225		1	+ 30	Poor water 922-1,000 feet.

[1] Record, 51st Congress, 1st session; Senate Ex. Doc. No. 222, pp. 210-211, Washington, 1890.
[2] Ibid., p. 217, Washington, 1890.
[3] Ibid., p. 204.
[4] Records, etc., ibid., pp. 213-214; analyses, ibid., p. 229.
[5] Record, Colorado, State Engineer 9th Biennial Report, 1897-1898, p. 29.
[6] Record, 51st Congress, 1st session, Senate Ex. Doc. No. 222, p. 207, Washington, 1890.
[7] Ibid., p. 211.

COLORADO—Continued.

Location.		Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
Town.	County.					
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Thatcher	Las Animas	936	5¼			
Timpas	Otero	795	6¼	35	Flows.	
Troy	Las Animas	400 or 500				
Trinidad	do					
Do	do	2,595	5¼	Many.	−195	
Walsenburg	Huerfano	1,250				For gas, entirely in shale. Salt water at −40 feet.
Westcliffe	Custer	500		None.		Abandoned.
Whiteriver	Rio Blanco	402				Salt water at 200 feet.
Do	do	506¼				Much gas at 500 feet.
Wray	Yuma	+500				For oil or coal; unsuccessful.

PUBLICATIONS RELATING TO DEEP BORINGS IN COLORADO.

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Artesian Wells of Colorado and their relation to irrigation. State Agricultural College, Bulletin No. 16, July, 1891, 28 pages.

Economic Geology, by George H. Eldridge, Geology of the Denver Basin in Colorado, United States Geological Survey, Monograph No. 27, pp. 317–465, Washington, 1896.

Underground Waters of the Arkansas Valley in Eastern Colorado, by G. K. Gilbert, United States Geological Survey, 17th Annual Report, 1895–1896, part 2, pp. 1–51, plates, Washington, 1896.

United States Geological Survey, Geologic Atlas of the United States, No. 36, Pueblo folio, by G. K. Gilbert, Washington, 1897.

United States Geological Survey, Geologic Atlas of the United States, No. 58, El Moro folio, by R. C. Hills, Washington, 1899.

United States Geological Survey, Geologic Atlas of the United States, No. 68, Walsenburg folio, by R. C. Hills, Washington, 1899.

CONNECTICUT.

Location.		Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
Town.	County.					
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Bridgeport	Fairfield	800		Several	No flow.	
Mansfield	Tolland	800	6	14	No flow.	
Meriden	New Haven	530	12	70	No flow.	Water very hard.
New Haven	do	3,800				Unsuccessful.
Noroton	Fairfield	700		None.		
Do	do	1,500		4	No flow.	4 gallons at 900 feet.
Pomfret Center	Windham	610	6	Few.	No flow.	
Putnam Heights	do	800		Few.	No flow.	
Do	do	400	6	4	No flow.	
Do	do	700		7	No flow.	
Do	do	420		2	No flow.	
Rockville	Tolland	3,440		Not any		Abandoned.
Stamford	Fairfield	450	8			Water unsatisfactory.

DELAWARE.

Location. Town.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Bowers Beach [1]		500	8¼	200	No flow.	Not much water below 240 feet.
Delmar [2]	Sussex					
Lewes [3]	do	400	6	15	At surface.	
Do. [4]		1,080		15	Flows.	
Middletown [5]	Newcastle	535	10-8	330	—50	Water also at 475 feet.
Do. [6]	do	698				Water from 535 and 660-686 feet.
Wilmington	do	400	8	15-18		
Do	do	1,077		10	—25	

DISTRICT OF COLUMBIA.

Washington, Heurich's old Brewery.		900		7		Abandoned.
Washington. Riggs House.		558		None.		Unsuccessful.

FLORIDA.

Apalachicola	Franklin	475	3¼			Temp., 68°.
Bartow (8 miles southwest).	Polk	600				Small vein of water at 300 feet.
Do	do	400				
Eau Gallie	Brevard	490	6		+ 48	Temp., 78°.
Fernandina [7]	Nassau	640	8	800	+ 50	Water from 618 feet.
Do	do	750	6		+ 64	Temp., 77°.
Fernandina (city park).	do	700	8	810	+ 40	Temp., 74°.
Fernandina	do	762				
Green Cove Springs	Clay	600	6	600	+ 30	Temp., 80°.
Heart's Road [7] (R. R. junction).	Nassau	750	6	Many.	+ 64	Temp., 77°.
Hobe Sound	Dade	1,100	4	Few.	Flows.	Sulphur water.
Jacksonville [8]	Duval	793	6		+ 17	
Do	do	711			Flows.	Do.
Do	do	630	6	432		Temp., 74° to 77°.
Do	do	660	6	[9] 950	+ 64	Do.
Do	do	1,020	10			Temp., 81°.
Do	do	937	12	432		Temp., 77°.
Do	do	490	3	180	+ 62	Temp., 75°.
Do	do	637	6	600	+ 62	Temp., 76°.
Do	do	650	6	900	+ 62	Do.
Do	do	1,020		2,333	+ 62	Temp., 78°.
Do	do		8-4			
Jasper	Hamilton	[8] +550				In progress.
Key West	Monroe	2,350				
Kissimmee	Osceola	406	4			
Lake Worth [10]	Dade	1,212	4	313	+ 40	
Live Oak	Suwanee	1,004	8	Many.	− 80	Temp., 60°.
Madison	Madison	530	6	100	−117	
Malabar	Brevard	510	3	Many.	Flows.	Temp., 78°; bored for oil; none found.
Melbourne	Brevard	400	6		+ 48	Temp., 78°.
Narcoossee	Osceola	416	3		− 27	
Ocala	Marion	1,210	8		− 74	
Orchid	Brevard	480	4	Few.	Flows.	Sulphur water.
Pasadena	Pasco	450			− 86	
Pensacola	Escambia	1,400				Navy-yard well. No good water.

[1] New Jersey Geol Surv., Report for 1899, p. 110.
[2] Record, ibid., pp. 111-112.
[3] Record, U. S. Geol. Surv., Bull. 138, p. 123.
[4] Record, New Jersey Geol. Surv., Report for 1898, pp. 83-87.
[5] Record, U. S. Geol. Surv., Bull. No. 138, p. 123.
[6] Record, New Jersey Geol Surv., Report for 1898, p. 115.
[7] Georgia Geol. Surv., Bull No. 7, pp. 75-76.
[8] Representative wells.
[9] Both wells.
[10] Record, etc., Am. Jour. Sci., 3d series, vol. 41, pp. 105-106.

FLORIDA—Continued.

Location. Town.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Punta Gorda	De Soto	467				Water too salty for use.
Do	do	400			Flows.	
Do	do	425		25	Flows.	Salt water only.
Quincy	Gadsden	610	6-4½		−190	
Riverside	Putnam			Many.	Flow.	2 wells.
Roseland	Brevard	462-450	6	Many.	Flow.	2 wells.
St. Augustine [1]	St. John	1,400		5,500		Temp., 86°. Strong flows also at 400-450 and 500-550 feet.
St. Nicholas	Duval	750	6		+ 60	Temp., 77°.
South Jacksonville	do	800			+ 55	
Do	do	750	6		+ 69	Do.
Tallahassee	Leon	715			− 98	

GEORGIA.

Abbeville [2]	Wilcox	540	4		− 25	Water at 90, 139, and 296 feet.
Albany	Dougherty	665	2	20	Flows.	
Do. [3]	do	700-780	6-4	20-115	+ 24	Numerous wells. Temp., 73½°.
Do. [4]	do	732	10	225	+ 30	
Albany (16 miles west).	do	550				Pure water.
Americus	Sumter	1,725	8-4		- 30	Water at 1,000 feet.
Do	do	400			− 10	Supply is derived from the 350-foot level.
Do. [5]	do	500			− 10	
Do	do	900			Flows.	
Do	do	550	4	33	+ 1	
Arlington [6]	Calhoun	625	6		− 20	Water at 500, 600, and 700 feet. Hard and slightly chalybeate.
Augusta [7]	Richmond	814	8	18	−196	
Do. [8]	do	879	6			Five water-bearing strata penetrated.
Bainbridge [9]	Decatur	900	6-2		− 50	
Do. [10]	do	1,325				Water at 280 and 350 feet.
Do	do	965	6-2		− 59	
Barrington [11]	McIntosh	450	3	200	+ 20	Flows at 350 and 450 feet.
Baxley [12]	Appling	507	6		−129	Water at 330 and 408 feet.
Bladen [13]	Glynn	480	3	100	+ 30	Water at 160, 280, and 475 feet.
Bowen's Mills	Wilcox	673	2½	60	+ 22	Temp., 74°.
Bradley's plantation [14].	Stewart	740	3		Flows.	Water from 475 feet.
Brunswick [15]	Glynn	450-490	3	200	+ 28	Numerous wells.
Do	do	415	3		+ 19	Temp., 62°.
Do	do	540	8	600	+ 12	
Do	do	430	4		+ 25	
Do	do	460	6	350	+ 12	
Do	do	465	4	600	Flows.	Temp., 70°.
Buena Vista [16]	Marion	583	10		−240	Water at 331 and 364 feet.
Camilla	Mitchell	600			No flow.	Nonflowing.
Chauncey [17]	Dodge	525	6		− 70	Water at about 300 ft.
Collins	Tatnall	800	8		−142	
Columbus, 3 miles south of.	Muscogee	425	3	2	− 4	Water at 400 feet.
Cookstown	Wilcox	+400			No flow.	3 wells reported.
Cordele [18]	Dooly	550	8		− 20	
Do	do	700	6		− 30	
Creytons Island [19]	McIntosh	414	3		+ 50	

[1] Am. Jour. Sci., 3d series, vol. 34, p. 70.
[2] Ga. Geol. Surv., Bull. No. 7, p. 151.
[3] Analysis and record, ibid., pp. 179-181.
[4] Record, ibid., pp. 178-179.
[5] Record and analysis, Ga. Geol. Surv., Bull. No. 7, pp. 174-176.
[6] Record, ibid., p. 185.
[7] Ga. Geol. Surv., Bull. No. 7, pp. 128-129.
[8] Ibid., p. 130.
[9] Analysis, ibid., pp. 160-161.
[10] Ibid., p. 162
[11] Ga. Geol. Surv., Bull., No. 7, p. 109.
[12] Ibid., p. 149.
[13] Ibid., pp. 92-93.
[14] Record, Ga. Geol. Surv., Bull. No. 7, p. 197.
[15] Ibid., p. 86.
[16] Ibid., p. 198.
[17] Ga. Geol. Surv., Bull. No. 7, p. 145.
[18] Record, Ga. Geol. Surv., Bull. No. 7, pp. 159-160.
[19] Ga. Geol. Surv., Bull. No. 7, p. 109.

GEORGIA—Continued.

Location. Town.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Cumberland Island [1]	Camden	600	4		+ 12	
Do. [2]	do	485	4		+ 12	
Do. [3]	do	680	6	555	+ 51	Water sulphurous.
Cuthbert	Randolph	1,000	6-4		− 30	Water also at 340-400 and 550 feet.
Damascus [4]	Early	547	2		− 7	Water also at 200 ft.
Darien	McIntosh	492	4			
Do. [5]	do	530	8	200	+ 15	
Dawson [6]	Terrell	650	5-2		− 45	
Doboy	McIntosh	450	6	250		
Drayton	Dooly	400	8	8	Flows.	Temp., 50°.
Dry Creek [7]	Burke	763	2		− 30	Water also at 280 and 375 feet.
Dublin	Laurens	850	8			First flow at 350 feet.
Duckers Station [8]	Dougherty	547	2		+ 10	
Eastman [9]	Dodge	680	4	Many.	−120	
Eastman	do	+600		Not any		Abandoned.
Do	do	720			−200	
Egypt [10]	Effingham	750	4		− 45	Water at 300 and 750 feet.
Evelyn	McIntosh	500	2		+ 45	Sulphurous water.
Do	Glynn	420	3		+ 14	Do.
Everett City	do	460	2		+ 38	
Everetts Station	Crawford	+400				
Fitzgerald [11]	Irwin	680	6-3		− 27	
Do	do	800	10		−150	
Do	do	1,000	6		−128	
Do	do	853	12-8	139	−320	
Florence, 3 miles west on Chattahoochee River.	Stewart	490	6	½	+ 20	
Do	do	490	2	½	+ 20	
Do	do	445		1¼	+ 30	
Do	do	455		½	+ 20	
Fort Gaines	Clay	650	4-3	150	− 20	Water at 500 feet.
Do	do	800		400	− 12	
Fort Valley [12]	Houston	1,075	6-4		-100	
Do	do	500		Not any		Abandoned.
Do	do	1,200		Not any		
Hawkinsville [13]	Pulaski	490	6		Flow.	Temp., 71°.
Irwinville	Wilkinson	600	3		(?) + 50	
Jekyl Island [14]	Glynn	480	6	250	+ 45	
Jesup [15]	Wayne	500	2		− 33	Water also at 287 feet.
Kingsland	Camden	475	2	60	Flows.	
Do [16]	do	500	2	33	+ 20	
Leary [17]	Calhoun	672	5-2	23	+ 30	
Leary, 3 miles north	do	400			No flow.	Abandoned.
Leesburg	Lee	500-600	8		No flow.	Temp., 68°. Mineral water.
Louisville [18]	Jefferson	450	4			Several wells. Those on low ground flow.
Lumber City [19]	Telfair	400	2	60	+ 14	6 wells. Water also at 300 feet.
Lyons [20]	Montgomery	400	3	10	− 84	Main water horizon at 375 feet.
McArthur [21]	do	900	3		− 60	Water at 419 and 890 feet.
Macon [22]	Bibb	955	12	Not any		Abandoned.
Manassas	Tatnall	498	6		−148	
Meldrim	Effingham	538	6	Many.	Flows.	
Milledgeville	Baldwin	600 or 700		Many.	No flow.	
Millen [23]	Screven	430-450	4-6		+19	Several wells.
Montezuma [24]	Macon	500		300	+62	2 wells.
Do	do	425		5	Flows.	Temp., 62°.
Do	do	425		2	Flows.	Do.

[1] Analysis, Ga. Geol. Surv., Bull. No. 7, pp. 78-79.
[2] Ibid., pp. 78-79.
[3] Record, ibid., pp. 76-77.
[4] Ga. Geol. Surv., Bull. No. 7, pp. 183-184.
[5] Record, ibid., pp. 105-108.
[6] Ibid., pp. 187-188.
[7] Ga. Geol. Surv., Bull. No. 7, p. 128.
[8] Record, ibid., p. 182.
[9] Analysis, ibid., pp. 144-145.
[10] Ga. Geol. Surv., Bull. No. 7, pp. 121-122.
[11] Ibid., p. 152.
[12] Record, Ga. Geol. Surv., Bull. No. 7, p. 192.
[13] Ibid., p. 140.
[14] Analysis, ibid., p. 94.
[15] Record, Ga. Geol. Surv., Bull. No. 7, pp. 103-104.
[16] Ga. Geol. Surv., Bull. No. 7, p. 79.
[17] Record, ibid., pp. 186-187.
[18] Ibid., p. 132.
[19] Ibid., p. 150; Analysis and record, U. S. Geol. Surv., Bull. No. 138, p. 224.
[20] Record, Ga. Geol. Surv., Bull. No. 7, p. 146.
[21] Ibid., p. 147.
[22] Ga. Geol. Surv., Bull. No. 7, p. 193.
[23] Ibid., pp. 123-124.
[24] Record, ibid., pp. 189-190.

GEORGIA—Continued.

Location.		Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
Town.	County.					
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Montezuma	Macon	450	2¼	30	+ 26	Flows at 60, 150, and 350 feet.
Do	do	450	4		+ 26	
Oglethorpe	do	490	2	66		Temp., 62°.
Pelicalville		430	4¼	400		Temp., ±70°.
Quitman [1]	Brooks	500?	6		− 30	Water at 109 feet.
Reynolds [2]	Taylor	700	8–4	60	− 80	
Riceboro [3]	Liberty	460	3	150	+ 20	
Do [4]	do	430	4	100	+ 24	Soft water.
Richland	Stewart	420	6	25	−120	
St. Marys [5]	Camden	525	4	Many.	+ 50	Water at 300 and 500 feet.
St. Simons Island	Glynn	480	6–3	100–150		3 wells.
Do. [6]	do	438	6	250	+ 40	Water 350 and 435 feet.
Savannah	Chatham	±650			− 18	
Do	do	1,500	12	Many.	No flow	
Do	do	500	10			2 wells reported.
Do	do	402–470	6	Many.		5 wells of old waterworks.
Do. [7]	do	475–700	12	13 wells 4,861		City waterworks comprising 13 wells.
Savannah (6 miles south).	do	1,147	4		+ 31	
Savannah (12 miles west on Great Ogeechee River).	do	±659			Flows.	Temp., 72°.
Sebastopol	Burke	676	6		− 2	Water at 200, 345, and 500 feet.
Smithville [8]	Lee	900	2¼, 4	Many.	+ 20	2 wells.
Statesboro	Bulloch	415	7–4¼	40	−100	
Do	do	(?) 600	4			
Swainsboro [9]	Emanuel	400	6	21	− 80	
Do	do	400	2	10	− 90	
Tarboro [10] (1½ miles northeast).	Camden	414	2	Many.	+ 50	
Tennille [11]	Washington	990	12–4	Many.	−190	Water at 426 and 830 feet.
Thomasville [12]	Thomas	1,900	5¼	Many.	−210	
Do	do	480	8	Many.	−210	
Union Island		475	4	150		
Valdosta [13]	Lowndes	522	8		−113	Temp. 70°. Water at 360, 450, and 515 feet.
Valona	McIntosh	455	3	120	+ 60	Temp., 70°.
Wadley [14]	Jefferson	445	6	Many.	+ 20	13 wells reported. Flow also at 330 feet.
Warwick [15]	Worth	497	8–2	1	− 5	Sulphur water.
Waycross [16]	Ware	700	12	750	− 60	2 wells, pure water.
Do	do	500	6	150		
Do	do	600	4		− 55	
Waynesboro [17]	Burke	992	6		+ 14	Water at 250, 300, and 900 feet.
Do	do	1,260	8		− 52	
Do	do	760			No flow	
Do	do	425			No flow	
Do	do	618	4		− 18	
Do	do	876	6			Abandoned.
Ways Station [18]	Bryan	460	3	200	+ 20	Water at 340 and 440 feet.
Do	do	484	6–2	Many.		
Whiteoak [19]	Camden	450	4	300	− 60	Water at 130 and 450 feet.
Wolf Island		500	2		+ 45	Sulphurous water.
Wright		785	6–3¼		− 80	
Wrightsville [20]	Johnson	672	8		− 60	Water at 430 and 672 feet.
Do	do	763	3		− 63	

[1] Record, Ga. Geol. Surv., Bull. No. 7, pp. 156–157.
[2] Ga. Geol. Surv., Bull. No. 7, p. 194.
[3] Ibid., pp. 110–111.
[4] Ibid., p. 110.
[5] Ga. Geol. Surv., Bull. No. 7, pp. 74–75.
[6] Ibid., pp. 87–92.
[7] Record, ibid., pp. 114–120.
[8] Ibid., pp. 176–177.
[9] Ga. Geol. Surv., Bull. No. 7, p. 43.
[10] Ibid., p. 83.
[11] Record, ibid., pp. 133–136.
[12] Ibid., pp. 158–159.
[13] Analysis, ibid., pp. 154–156.
[14] Record, Ga. Geol. Surv., Bull. No. 7, p. 131.
[15] Ga. Geol. Surv., Bull. No. 7, p. 164.
[16] Record and analysis, ibid., pp. 96–102.
[17] Record, ibid., pp. 125–126.
[18] Ga. Geol. Surv., Bull. No. 7, pp. 111–112.
[19] Ibid., p. 82.
[20] Ibid., pp. 137–138.

PUBLICATIONS RELATING TO DEEP BORINGS IN GEORGIA.

Preliminary report on the artesian well system of Georgia, by S. W. McCallie, Geological Survey of Georgia, Bulletin No. 7, 214 pages, plates, Atlanta, 1898.

Artesian prospects in the Atlantic Coastal Plain region, by N. H. Darton, United States Geological Survey, Bulletin No. 138, 232 pages, plates, Washington, 1896.

IDAHO.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Boise	Ada	450		270	+ 10	Temp., 80°. Deepest of several wells. Hot wells average 555 gallons per minute, and have a height of +30 feet. Temp., 170°.
Bliss	Lincoln	483	8			
Clift		450	8			
Idaho City	Boise	+400				Prospect well. Not in use.
Minidoka	Lincoln	425				
Oakley	Cassia	±400				
Owinza	Lincoln	400				

ILLINOIS.

Aledo [1]	Mercer	3,115		Many.	— 75	Water at 1,200 feet. Salty water from 2,300 to 2,620 and 3,071 feet.
Algonquin [2]	McHenry	2,527				Bad water. Abandoned.
Alton	Madison	890	6-4	35-40	Flows.	2 wells; mineral water.
Amboy [3]	Lee	2,000			+ 3	Temp., 55° to 60°. Water at 300, 1,100, and 1,700 feet.
Aurora [3]	Kane	663				
Do. [3]	do	1,388	8-6	350		
Do. [3]	do	2,270			+ 60	
Do. [3]	do	2,255			+ 60	
Austin [4]	Cook	1,205		Many.		
Barry [5]	Pike	2,510	6	100	- 35	
Beardstown [6]	Cass	1,070		17		Water, oil, and gas.
Belleville	St. Clair	503			— 80	
Belvidere [4]	Boone	1,950	8-4	400	— 6	
Do	do	1,932	8-6	200	— 6	
Benton	Franklin	780	5	3	— 12	
Bethalto	Madison	1,000	12	15	— 25	Saline water.
Bradford	Stark	2,454	8-6	Many.	—175	
Braidwood	Will	900	4		At surface.	Water from 655 feet.
Cairo	Alexander	700-750		556	+ 10	4 wells.
Do	do	1,025				No water below 750 feet.
Cambridge	Henry	1,329	9-6	74	—146	
Camppoint	Adams	1,006				
Canton [7]	Fulton	2,500	4	125	+ 31	Water from 2,050 feet.
Do. [7]	do	1,646¼	14-6	260	+ 15	Water from 1,100 to 1,305 feet and 1,403 to 1,646¼ feet.
Do. [8]	do	2,333				Unsuccessful.
Carbon Cliff [9]	Rock Island	915	5¾	400	+ 50	Brackish water at 850 feet.
Do. [7]	do	950				
Carmi	White	600		Many.	Flows.	
Carrollton [7]	Greene	1,330			— 50	Water from 1,225—1,330 feet.

[1] U. S. Geol Surv., 17th Ann. Rept., 1895-96, part 2, p. 810.
[2] Ibid., p. 810.
[3] Analysis, ibid. p. 820.
[4] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 810.
[5] Analysis, ibid., p. 827.
[6] Record, Ill. Geol. Surv., pp. 61, 66.
[7] Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 849.
[8] Record, Ill. Geol. Surv. Rept., vol. 8, pp. 62-63.
[9] Record, ibid., pp. 64-65.

ILLINOIS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Carthage [1]	Hancock	1,800	5-3		− 16	Brackish water at about 750 and 1,000 feet.
Do. [1]	do	1,000	10-8		− 20	Water at 865 and 975 feet.
Do. [2]	do	1,787			+ 5	Mineral water.
Do. [3]	do	975		Many.		Do.
Centralia [4]	Marion	864	6			Unsuccessful.
Champaign	Champaign	400				
Charleston	Coles	2,600				Salt water at 160 and 815 feet.
Do	do	748½				
Chatsworth [5]	Livingston	1,200			− 25	
Chicago [6]	Cook	694	5		− 13	Hard water, original head +77 feet.
Do. [7]	do	711	4½	400	− 13	Original head +77 feet.
Do	do	1,400				Unsuccessful.
Do. [8]	do	1,200			At top.	Hard water.
Chicago (Union Stock Yards). [8]	do	1,105				
Chicago (Lehman Well).	do	2,604				Brackish water.
Chicago (Swift & Co.)	do	2,700				
Chicago (Stockton)	do	2,180 2,186		840	− 30	2 other wells.
Collinsville	Madison	573			−120	
Columbia	Monroe	1,010	5½		− 10	Water not pleasant.
Coulterville	Randolph	1,117				Water brackish
Do	do	1,201				No gas or oil found
Danville Junction	Vermilion	2,008				Brackish water at 1,700 to 1,735 feet.
Decatur [9]	Macon	507				
Dekalb	Dekalb	800	8-6	Many.	− 25	
Do	do	880	10-8	Many.	− 55	
Do	do	890	14-6	300	− 65	Water 125 to 161 and 595 to 890 feet.
Do	do	981	6-4	Many.	− 60	
Do	do	700		Many.	− 40	
Denver (near)	Hancock	1,030		Many.	− 40	
Divernon	Sangamon	604		Not any		Coal prospect.
Dixon [10]	Lee	1,640 1,730 1,810		Many.		3 wells.
East Dubuque	Joe Daviess.	940	5		− 95	
East Moline	Rock Island	1,340	6	240	+ 36	750 and 1030 to 1080 feet.
East Peoria	Tazewell	734				Brackish water at 317 and 734 feet.
East St. Louis	St. Clair	1,100				Good drinking water, but unfit for boilers.
Eldorado	Saline	520	3½	Few.		
Elgin [11]	Kane	1,400				Water at 487 to 514 feet; sulphur water at 650 to 700 feet.
Do. [12]	do	1,876			+ 2	Also sulphur water at 650 to 700 feet.
Do. [12]	do	2,026	6		+ 27	Sulphur water at 650 to 700 feet; soft water at 2,024 feet.
Do. [13]	do	2,230			− 4	Also sulphur water at 650 to 700 feet.
Equality	Gallatin	1,800	6-3½			Very salt water at 900 feet.

[1] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 810.
[2] Record, Ill. Geol. Surv. Rept., vol. 8, pp. 64-65.
[3] Record, ibid., p. 62.
[4] Record, Economic Geology of Ill., vol. 2, pp. 138-139.
[5] Record, Economic Geology Ill., vol. 3, pp. 595-596.
[6] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 811.
[7] Ibid., p. 811.
[8] Record, Economic Geology Ill., vol. 2, p. 186.
[9] Record, Economic Geology Ill., vol. 3, pp. 538-539.
[10] Analysis, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 827.
[11] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 812.
[12] Ibid., p. 812.
[13] Ibid., p. 812; Analysis, ibid., p. 827.

ILLINOIS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Evanston [1]	Cook	1,602			+ 5	Water at 562 to 832 feet.
Fairbury [2]	Livingston	571				Water at 427 feet.
Do	do	2,002	8		− 60	
Franklin	Morgan	1,200				Flow for gas unsuccessful.
Fulton [3]	Whiteside	1,246	5	300	+ 61	First flow, 475 feet; sulphur water.
Galena [4]	Jo Daviess	1,209	8	166	+ 85	
Galesburg [5]	Knox	1,236				City waterworks well No. 2.
Do. [6]	do	1,226	14–6	120	−102	Water at 1,060 to 1,226 feet.
Galva	Henry	1,470	9–6	50	−178	
Geneseo [7]	do	2,250	6	190	− 31	
Gilman	Iroquois	1,746		150	− 7	
Greenup	Cumberland	640	2			Mineral water.
Hamilton	Hancock	690		36	+ 63	Sulphur water.
Harvard	McHenry	900	12–7	90	− 41	Hard water.
Harvey	Cook	1,300 2,075		250	− 10	2 wells.
Hawthorne	do	989				
Do	do	2,005½				
Hennepin	Putnam	800	4	80	+ 50	Slightly saline water.
Henry	Marshall	1,355	3¼	32		White sulphur water.
Highland Park [8]	Lake	2,200	8–5	150	+ 9	Water at 900, 1,300, and 1,700 to 2,200 feet; slightly saline and hard.
Hinsdale	Dupage	864				
Ipava [9]	Fulton	1,570	4	60		Also salty and sulphurous water at about 1,010 feet.
Jacksonville [10]	Morgan	1,600				For gas.
Do. [11]	do	2,343	6–4½	30	− 15	Water brackish at 2,340 feet.
Do. [12]	do	2,408	5½	85	+ 10	Water brackish at about 2,100 feet.
Do. [12]	do	3,028	6½–5½	500	− 30	Water from 1,800 and 3,000 feet; slightly saline.
Jerseyville [13]	Jersey	2,003	12–3	200	100	Water at 1,400 to 1,600 feet.
Joliet [14]	Will	477		Many.	Flows.	
Do	do	1,200		500		
Do. [15]	do	1,700			+ 10	
Do. [16]	do	2,076			+ 10	
Kankakee [17]	Kankakee	1,000	4		− 15	Water from 900 feet.
Kewanee [15]	Henry	1,480	9–6	130	150	Water from 1,000 feet.
Do. [18]	do	1,050	7–4	80		2 wells.
Knoxville [19]	Knox	1,350	8	80		Water from 1,180 to 1,350 feet.
Ladd [20]	Bureau	460		135	Flows.	Shaft for coal. Flowed 3 gallons at 28 feet, 200 gallons at 173 feet, then decreased to 135 gallons.

[1] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 813; Analysis, Ibid., p. 827.
[2] Ill. Geol. Surv., vol. 6, p. 242.
[3] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 813.
[4] Ibid., p. 813; Analysis, p. 827.
[5] Analysis, Am. Inst. Mining Engineers, Trans., vol. 27, p. 135.
[6] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 813.
[7] Ibid., p. 813; Analysis, p. 827.
[8] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 813.
[9] Ibid., p. 813.
[10] Ill. Geol. Surv., vol. 8, p. 67.
[11] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 814; Analysis, Ibid., p. 820.
[12] Ibid., p. 814; Analysis, ibid., p. 820.
[13] Ibid., p. 814; Analysis, pp. 808, 827.
[14] Record, Economic Geol. Ill., vol. 2, pp. 482, 487.
[15] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 814; Analysis, Ibid., p. 821.
[16] Record, Ibid., pp. 799, 814.
[17] Ibid., p. 814; Analysis, ibid., p. 821.
[18] Ibid., p. 814; ibid., p. 821.
[19] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 814.
[20] Columbia College, School of Mines Quarterly, vol. 16, pp. 238–243.

ILLINOIS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Lagrange	Cook	2,014			No flow.	
Lake Forest [1]	Lake	960		60	+ 50	
Lancaster [2]	Wabash	+800	6			For oil; unsuccessful.
Lasalle [1]	Lasalle	502	6	200		
Lemont	Cook	1,366			+ 60	
Litchfield [3]	Montgomery	682				Oil with salt water and gas.
McLeansboro	Hamilton	800	8-5¼	3¼		
Macomb	McDonough	1,350			− 55	
Do. [4]	do	1,630				Water from 1,135 to 1,360 feet.
Marion	Williamson	1,715			Flow.	For gas and oil. Sulphurous and salt water found.
Marissa	St. Clair	685		35	No flow.	
Marseilles [5]	Lasalle	2,189		1	Flow.	Flow is from 298 feet.
Marshall	Clark	500				2 unsuccessful oil borings.
Mattoon	Coles	1,647	8	Many.		Salt water at 306 feet, and very salty at 1,500 feet.
Mendon	Adams	1,020				
Mendota [6]	Lasalle	400			− 47	
Do. [7]	do	857			+ 14	Flows at 187 and 637 feet.
Milan [8]	Rock Island	1,217				
Do. [9]	do	1,157	8-5	318	+ 61	Water from 800 and 1,000 feet.
Millstadt	St. Clair	620	7¼	4	− 75	Hard water.
Minonk	Woodford	1,755		100	−149	Moderately hard water at 750 feet and at about 1,700 feet.
Minorka	Gundy	2,100			+ 46	
Moline [10]	Rock Island	1,166		250	+ 25	
Do. [11]	do	1,628	5	350	+ 82	Sulphur water at about 700 feet.
Monmouth [12]	Warren	1,232				No flow water; no gas; no oil.
Do	do	1,400	6-4	210	− 60	
Do. [13]	do	1,230		200	− 60	Water from 1,074 to 1,230 feet.
Do. [14]	do	1,227			− 60	Water at 935 and from 1,074 to 1,227 feet.
Monticello	Piatt	1,100				Flow of mineral water also.
Morgan Park	Cook	1,046			45	Water at 1,040 feet.
Morris [15]	Grundy	406	10	Many.	Flows.	
Do	do	600				
Mount Carmel [16]	Wabash	700				Bored for oil.
Mount Carroll	Carroll	2,502	5			Much water at 1,200 feet; less from 1,300 to 2,500 feet.
Murphysboro	Jackson	509	8			Good water at 400 feet; saline water at 450 feet.
Oakpark	Cook	1,568	6¼	500	−20	Water from 1,529 feet.
Do	do	2,200			−20	Water from 1,600 and 2,200 feet.
Olney [17]	Richland	2,000			No flow.	Saline water.

[1] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 814.
[2] Record, Economic Geol. Ill., vol. 3, pp. 58-60.
[3] Record Ill. Geol. Surv., vol. 7, p. 37.
[4] Analysis, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, pp. 808, 827.
[5] Record, Ill. Geol. Surv., vol. 8, p. 50.
[6] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 815.
[7] Record, Minnesota Geol. Surv., 13th Ann. Rept., pp. 55, 56.
[8] U. S. Geol. Surv., 17th Ann Rept, 1895-96, part 2, p. 846.
[9] Ibid., p. 815; Analysis, ibid., pp. 808, 827.
[10] Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, pp. 847, 848.
[11] Record, ibid., p. 848; Analysis, ibid., pp. 808, 827.
[12] Record, Ill. Geol. Surv. Reports, vol. 8, pp. 62-66.
[13] Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 848; Analysis, ibid., pp. 808, 827.
[14] Record, ibid., p. 848; Analysis, ibid., pp. 808, 827.
[15] Record, Economic Geol. Ill., vol. 2, p. 457.
[16] Record in part, Economic Geol. Ill., vol. 3, pp. 386-387.
[17] Ill. Geol. Surv. Reports, vol. 7, p. 8.

ILLINOIS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Ottawa[1]	Lasalle	400				Has 200 wells 400 feet deep. Water from 290 to 400 feet.
Do.[2]	do	1,840			+177	Water from 1,640 to 1,840 feet.
Palatin[3]	Cook	1,656			+2	Water at 160 and 800 feet.
Pana	Christian	2,507		Few.		Brackish water.
Paris	Edgar	2,200	8	Not any		
Park Ridge	Cook	1,500	6-3		−10	
Paxton	Ford	2,100 or 2,600.		Many.		
Pedicord	Lasalle	2,189		8	At surface.	Water from Potsdam 1,845 to 2,143 feet.
Pekin	Tazewell	850				Salt at 500 feet.
Do	do	1,000	6	167	+65	Salt water at 425 feet. Lower water strongly sulphurous. Temp., 70°.
Peoria (opposite)[4]	Peoria	734			+60	Sulphur water.
Peru[5]	Lasalle	1,360		200	+120	Water at 750 feet also.
Polo	Ogle	2,098		Many.		
Potsdam		1,500		Many.		
Princeton[6]	Bureau	2,500			−72	
Do	do	2,092	9-4	320		Water hard, slightly saline from 1,521 to 1,670 feet and 1,850 to 1,975 feet.
Do[7]	do	400				
Quincy	Adams	550-1,000				5 wells.
Ramsey	Fayette	+400				
Redbud	Randolph	580	3	4	+ 7	
Do	do	1,350	4		−20	
Review		1,400	6			Temp., 62°.
Do		1,233		208	54	Salt water from 600 to 1,008 feet.
Riverside[8]	Hancock	680		35	+63	Mineral water.
Do	do	1,300 / 2,200	3	1,000	+20	
Riverton[9]	Sangamon	2,584				No gas, oil, or water found.
Rock Island[10]	Rock Island	1,150	4	400	+70	Sulphur water at 750 and 980 feet.
Do.[11]	do	2,282	8-4		+50	Also sulphur water at 800 feet.
Rockford[12]	Winnebago	1,300-1,996	8-6	116-260	+ 8	Five wells. Water from 380 to 400 feet and 1,200 to 1,300 feet.
Do.[13]	do	400	6		− 8	
Rushville	Schuyler	2,500				Water has unpleasant taste.
St. Johns[14]	Perry	1,050		6		6 salt wells; brine at 970 feet.
Do	do	3,750				
Savannah	Carroll	1,432		500	+83	
Seneca	Lasalle	600-650				2 wells.
Do.[15]	do	680	4		+15	Water, which is hard and sulphurous, is from 350 and 380 feet.
Shelbyville	Shelby	1,200	6		Flows.	Water is saline, and from 625 feet.

[1] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 816.
[2] Record, ibid., pp. 798-799.
[3] Ibid., p. 816.
[4] Economic Geol. of Ill., Vol. 2, p. 449.
[5] Analysis, U. S. Geol Surv., 17th Ann. Rept., 1895-96, part 2, p. 828.
[6] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 816; Analysis, ibid., pp. 808, 828.
[7] Record, Economic Geol. of Ill., vol. 3, p. 178.
[8] Record, Ill. Geol. Surv., vol. 8, pp. 64-65.
[9] Ill. Geol. Surv. Reports, vol. 8, p. 62.
[10] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 816; Analysis, pp. 808, 828; Record, pp. 845-846.
[11] Ibid., pp. 817, 845.
[12] Ibid., p. 816; Analysis, p. 828.
[13] Analysis, ibid., p. 828.
[14] Ill. Geol. Surv., vol. 7, p. 38.
[15] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 817.

ILLINOIS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Sheldon	Iroquis	1,800	10-5	100	−40	
Shawneetown[1]	Gallatin	1,513				For oil, only salt water found.
Do.[2]	do	1,500				At 500 feet, small vein gas; at 1,500, large quantity salt water.
Sparta[1]	Randolph	480			−75	
Springfield[3]	Sangamon	Nearly 1,200.			No flow.	
Sterling[4]	Whiteside	1,450		350	At surface.	
Streator[5]	Lasalle	2,496			+45	Water at 450, 2,170 to 2,496 feet.
Tuscola	Douglas	792				
Do	do	3,000	9-6			Temp., 60°.
Vermilion[6]	Lasalle	1,000		Many.	Flows.	Flows begin at 380 feet; water slightly saline.
Virginia	Cass	750				Water at 730 and 750 feet: unfit for drinking.
Washington Heights	Tazewell	1,308				
Warsaw	Hancock	780-800	4	100	+ 65	3 wells; water sulphurous.
Do	do	750	6	90	+155	Do.
Do	do	860	6	200	+ 62	Original head +98.
Waterloo	Monroe	1,036	9¼-7¼	20		20-gallon flow at 80 feet also. Temp., 50°.
Waukegan	Lake	1,135 1,600 2,005				Irony water; 3 wells.
Wenona	Marshall	1,854		100	− 25	
West Frankfort	Franklin	465				Coal prospect.
Wilmington[7]	Will	635	4¼		46	Sulphurous and magnesia water from 400 to 635 feet.
Winchester	Scott	412			+ 25	Water from 350 feet.
Winnetka[8]	Cook	1,570		150	+ 8	Original head, +18 feet.
Do	do	1,900				
Woodstock	McHenry	1,014		500		
Do	do	410	5		−130	

[1] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 817.
[2] Ky. Geol. Surv. Rept. Petroleum, Natural Gas, etc., by E. Orton, p. 205.
[3] Ill. Geol. Surv. Reports, vol. 5, p. 312.
[4] Analysis, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 828.
[5] Ill. Geol. Surv., vol. 7, pp. 50, 59; Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 798; Analysis Ibid., p. 821.
[6] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 818; Economic Geol. Illinois, vol. 2, p. 235.
[7] U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 818.
[8] Analysis, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 828.

PRINCIPAL PUBLICATIONS RELATING TO DEEP BORINGS IN ILLINOIS.

Illinois Geological Survey, Reports on Geology and Palæontology, volumes 5, 1873; 6, 1875; 7, 1883, and 8, 1890.

Economical Geology of Illinois, by State geologist, volumes 2 and 3, Springfield, 1882.

The Water Resources of Illinois, by Frank Leverett, United States Geological Survey, Seventeenth Annual Report, 1895-96, part 2, pp. 695-849, plates, Washington, 1896.

INDIANA.

The numerous deep borings in Indiana are for oil or gas, but a few of them yield water supplies. The wells are in groups or "districts," often many square miles in extent. Where localities given in the following list are in districts, only representative wells are described, for it would not be practicable here to list all the individual wells. In some localities new wells are constantly being sunk.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Adams	Decatur	± 800				Gas well.
Alexandria	Madison	881				Gas wells.
Amboy [1]	Miami	940				Salt water at 385 feet.
Albany [2]	Delaware	978				Gas well.
Albion [3]	Noble	1,914				For gas; unsuccesful.
Anderson [4]	Madison	800				Water, mineral; city supply in part.
Do. [5]	do	800-900	8		—25	Gas wells in vicinity.
Arcadia [6]	Hamilton	974				Gas well.
Atlanta	do					Do.
Attica	Fountain	900			Flows.	Sulphurous water.
Auburn	Dekalb	+1,933				Gas wells.
Aurora [7]	Dearborn	1,000				Brackish water at 195 feet, brine at 831 feet, and gas at 267 feet.
Bloomington [8]	Monroe	2,730				No good water; abandoned.
Bluffton	Wells	100-500				Hard water.
Do. [9]	do	1,200				For gas; unsuccessful; salt water.
Boone Landing	Floyd					Gas wells.
Boonville	Warrick	1,400			No flow.	Gas well.
Boonville (4 miles west).	do	1,500	10 or 12		No flow.	
Boonville	do	1,200	12		Flows.	Salt water.
Bridgeport [10]	Marion	1,200				Gas well.
Brightwood	Marion	455			— 15	Several wells.
Do	do	476	8	139	- 60	Railroad well.
Do	do	1,181				Some gas, oil, and salt water.
Broad Ripple	do	+ 950				Gas wells.
Brookville (4 miles south). [11]	Franklin	1,254				Do.
Brownstown [12]	Jackson	1,891			—291	Flow of magnesia water at 565 feet; salt water at 1,891 feet.
Bryant	Jay	1,050				Oil well; abandoned.
Bunker Hill [13]	Miami	+1,004			— 20	For gas; unsuccessful; salt water.
Butler	Dekalb	600				Hard water.
Do [14]	do	2,139				For gas, unsuccessful; salt water.
Cadiz	Henry					Gas wells.
Cambridge	Wayne	+ 886				For gas; unsuccessful.
Camden	Jay					Gas wells.
Cannelton	Perry	750	8-5½		—150	Water and oil.
Carbon (2 miles south).	Clay	936				Not successful.
Do	do	1,255	10		— 40	Good water at 350 feet.
Carmel	Hamilton					Gas well; small product.

[1] Record, Ind. Geol. and Nat. Hist. Surv., 16th Rept., 1888, pp. 186, 187.
[2] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 715.
[3] Ibid., p. 737.
[4] U. S. Geol. Surv., 18th Ann. Rept., 1896-97, part 4, p. 487.
[5] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, pp. 711-713.
[6] Ibid., p. 699.
[7] Ibid., p. 705.
[8] Record, Ind. Geol. and Nat. Hist. Surv., 15th Rept., 1885-86, p. 332.
[9] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 740.
[10] Ibid., p. 701.
[11] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 707.
[12] Ibid., p. 726.
[13] Ind. Geol. and Nat. Hist. Sem., 16th Ann. Rept., 1888, p. 186.
[14] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 738.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Carthage[1]	Rush					Gas near 1,257 feet.
Centerville	Wayne	+ 886				For gas; unsuccessful.
Chandler	Warrick	1,505				2 flows of salt water and some gas.
Charlottesville	Hancock					Gas well.
Chesterfield[2]	Madison	948				Do.
Cicero	Hamilton					Gas well.
Circleville	Tipton	+1,078				For gas; unsuccessful.
Columbia City[3]	Whitley	1,375			— 20	For gas; unsuccessful. Salt water.
Columbus[4]	Bartholomew	1,700				Gas well.
Como	Jay					Do.
Connersville[5]	Fayette	851	8			Do.
Converse	Miami	200-435				Hard water; brackish water at 435 feet.
Do.[6]	do	900-950				Gas wells in vicinity.
Corydon	Harrison[7]	1,200				Gas boring.
	do	423-728	8-5¼			Fresh water 30-130 feet; also salt water in lower strata.
Covington (3 miles below).	Fountain	1,000				
Cowan	Delaware	+ 935				Gas well.
Crawfordsville[8]	Montgomery	1,544				For gas; unsuccessful. Sulphur water at 750 feet.
Crown Point[9]	Lake	1,365			—120	For gas; unsuccessful. Salt water.
Do.[10]	do	3,300				Not successful.
Cumberland	Marion	+1,039				Salt water.
Daleville	Delaware	+ 870				Gas well.
Dalton	Wayne	+ 960				For gas; unsuccessful.
Danville	Hendricks	830				Abandoned.
Do	do	1,500	8-5	30		First water at 700 feet.
Decatur[11]	Adams	1,300				For gas; unsuccessful. Salt water.
Deer Creek (one-half mile south).	Carroll	± 840	6-4			Oil at 825 feet; salt or mineral water at 833 feet.
Delphi[12]	do	914				For gas; unsuccessful.
Do	do	1,200				
Delphi (2 miles southwest).[13]	do	923	6-4			Salt or mineral water at 923 feet.
Delphi (northeast)	do	928	6-4			Salt or mineral water at 928 feet; also oil.
Delphi (southeast, at water tower).	do	947	6-4		Flows.	Salt or mineral water at 922 feet; also oil and gas.
Delphi (southeast)	do	1,315	6-4		Flows.	Salt or mineral water at 898 feet; also oil and gas.
Delphi (northwest)	do	1,385	6-4			Salt or mineral water at 923 feet.
Desoto	Delaware					Gas well.
Dublin	Wayne	1,250			—250	Gas well.
Dunkirk	Jay	± 925				Gas wells.
Dunreith	Henry					Gas well.
Earl Park	Benton	1,000	5			Abandoned.
Eagletown	Hamilton					Gas well; small product.
Eaton[14]	Delaware					Gas well.

[1] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 704.
[2] Ibid., pp. 709-713.
[3] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 736.
[4] Ibid., p. 722; U. S. Geol. Surv., 18th Ann. Rept., 1896-97, part 4, pp. 487-488.
[5] U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 721.
[6] Ibid., pp. 690-691.
[7] U. S. Geol. Surv., 18th Ann. Rept., 1896-97, part 4, p. 488; Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 725.
[8] Record, U. S. Geol. Surv., 11th Ann. Rept., part 1, 1889-90, p. 729.
[9] Ibid., p. 734.
[10] Borings preserved in county auditor's office.
[11] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 740.
[12] Ibid., p. 731.
[13] Record, Mich. Geol. Surv., 1881-1893, p. 54, pl. 14.
[14] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 713.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Edinburg[1]	Johnson	1,583			− 83	For gas; salt water only.
Elizabethtown	Bartholomew.	+ 914				Gas well.
Elkhart[2]	Elkhart	+ 615	5¼		Flowed.	For gas; unsuccessful. Salt water at 550 feet.
Elwood	Madison	± 936				Gas well.
English (8 miles south).	Crawford	700	3	11	+ 35	
Do	do	887	8	8	+ 50	
English, Clark well[3]	do	648				Gas at 408 feet; salt water at 648 feet; some oil.
Evansville	Vanderburg	1,100				Several wells; brackish water.
Do[4]	do	1,829				Salt water at 1,400 feet.
Do	do	1,500				
Fairmount[5]	Grant	500–1,000	8–4			Gas wells.
Farmland[6]	Randolph	1,017				Do.
Fisher's Station	Hamilton					Do.
Flora	Carroll	±1,100	6–4			Salt water at 1,040 feet; also oil.
Florida	Madison					Gas well.
Fontanet	Vigo	± 400	8		− 12	
Fontanet (one-half mile southwest).	do	440		Many.		
Fontanet (3 miles southwest).	do	1,451	8–4	Many.		Water at 400 feet.
Fortville	Hancock	(?)				Gas wells.
Fort Wayne	Allen	250–450		5,000 in all.	−6(?)	54 wells at waterworks.
Fort Wayne (Bass foundry.)	do	1,458				For gas; unsuccessful.
Fort Wayne (Abott's addition).[7]	do	1,900			−900	For gas; unsuccessful; mineral water.
Fort Wayne (courthouse).	do	3,000			− 8	For gas; unsuccessful.
Fountain City	Wayne	+1,025				Do.
Francesville	Pulaski	+890				Oil and gas; unsuccessful.
Frankfort[8]	Clinton	1,446			−600	Salt water at 1,200 feet.
Frankfort (4 miles east).	do	1,105				For gas; unsuccessful.
Franklin[9]	Johnson	1,113				
Frankton	Madison	840				Gas well.
Fulton	Fulton	1,150				Salt water only; abandoned.
Galveston[10]	Cass	860				
Do	do	934				Salt water only.
Garrett	Dekalb					Small gas well.
Glenwood	Rush	+950				For gas; unsuccessful.
Goshen[11]	Elkhart	2,059			Flows.	For gas; unsuccessful; salt water.
Gosport	Owen	926		Many	+30	White sulphur water.
Greencastle	Putnam	1,200	6			For gas; unsuccessful.
Do	do	2,000–2,700	8–4		Flow.	Several borings; water at several horizons.
Greenfield[12]	Hancock	990				Gas wells.

[1] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, part 1, p. 728.
[2] Ibid., p. 735; Michigan Geol. Survey, 1881–1893, p. 57, Pl. XVII.
[3] Record, Ind. Geol. and Nat. Hist., 17th Ann. Rept., 1891, p. 311.
[4] Ky. Geol. Surv. Petroleum, Natural Gas, etc., by Orton, pp. 197–98.
[5] U. S. Geol. Surv., 11th Ann. Rept., 1889–90, part 1, p. 685.
[6] Ibid., pp. 688–689.
[7] Analysis and record, Ind. Geol. and Nat. Hist. Surv., 16th Ann. Rept., 1888, pp. 129–130.
[8] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, part 1, p. 730.
[9] Ibid., p. 727.
[10] Record, Ind. Geol. and Nat. Hist., 19th Ann. Rept., 1894, p. 39.
[11] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, part 1, p. 735; Mich. Geol. Surv., 1881–1893, p. 60, pl. 19.
[12] Record, U. S. Geol. Surv., 11th Ann. Rept., part 1, pp. 701–702.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Greensburg [1]	Decatur	862-886				Numerous gas wells.
Greensboro (near)	Henry					Gas well.
Greentown	Howard	963				Do.
Greenwood	Johnson	600			− 45	Water from 320 feet.
Do. [2]	do	1,975			−240	For gas; unsuccessful; water at 1,840 and 1,865 feet.
Hagerstown	Wayne	766-1,025				Several gas wells.
Hammond	Lake	1,700-1,900				Several wells.
Hartford	Jay	±925				Gas wells.
Hartford City [3]	Blackford	900-1,000				Over 1,000 wells for oil and gas in the county.
Hartsville	Bartholomew	+861				Gas well.
Hebron	Porter					For gas; unsuccessful.
Herbst Station	Grant	1,045				Gas well.
Honey Creek	Henry	+980				Gas wells.
Huntington [4]	Huntington	1,037			− 87	For gas; unsuccessful.
Huntsville	Madison					Gas well.
Indianapolis	Marion	950-1,039				For gas; unsuccessful.
Do. [5]	do	1,520				Do.
Irvington	do	990				Gas well.
Jasper	Dubois	1,100	8			Salt water at 460 feet, gas at 600 feet, oil and mineral water at 955 feet.
Jeffersonville [6]	Clark	960-1,216				For gas; unsuccessful.
Joliet	Hamilton					Gas well; small flow.
Jonesboro [7]	Grant	935				Gas well.
Kempton [8]	Tipton	1,035				
Kendallville	Noble	+1,920				For gas; unsuccessful.
Kentland	Newton	1,200			− 60	
Do	do	1,325				Do.
Kewanna [9]	Fulton	1,089			− 84	Do.
Kirklin	Clinton	1,089				Do.
Knox	Starke	±1,500				Borings for gas or oil; unsuccessful.
Kokomo [10]	Howard	920-1,000		Many.	Flows.	Gas wells; much salt water.
Do	do			Many.		
Do	do				Flows.	
Knightstown	Henry					Gas well.
Lacrosse (3 miles distant).	Laporte	838			At surface.	Good water.
Lafayette [11]	Tippecanoe	410				
Do	do	1,000				Gas well.
La Fontaine [12]	Wabash	920				Gas well.
Lapelle	Madison					Do.
Laporte	Laporte					For gas; unsuccessful.
Larwell [13]	Whitley	1,593			−200	For gas; unsuccessful; salt water.
Lawrence	Marion	1,015			−315	
Lawrenceburg	Dearborn					Gas wells.
Lebanon [14]	Boone	1,350-1,840				Several wells; saline water at 400 and 1,350 feet.
Leesburg	Kosciusko	1,800	5			
Liberty [15]	Union	971	8-10			For gas; unsuccessful.

[1] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, pp. 703-704.
[2] Ibid., p. 728.
[3] Ibid., pp. 678-681.
[4] Ibid., p. 739.
[5] Record, Ind. Geol. and Nat. Hist., 1885-86, 15th Rept., p. 331.
[6] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 724.
[7] Ibid., p. 688.
[8] Ibid., p. 696.
[9] Ibid., p. 733.
[10] Ind. Geol. and Nat. Hist. Surv., 1885-86, 15th Ann. Rept., pp. 323-326; U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, pp. 691-693.
[11] Ind. Geol. and Nat. Hist. Surv., 1885-86, 15th Ann. Rept., pp. 69-71.
[12] Record, etc., U. S. Geol. Surv., 11th Ann. Rept., 1889-'90, part 1, pp. 689-690.
[13] Ibid., p. 736.
[14] Ibid., p. 730.
[15] Ibid., pp. 720-721.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Liberty (8 miles from).	Union	1,000	8-10			For gas; unsuccessful.
Lodi[1]	Fountain	1,155	10	35	+ 43	For oil; yields mineral water.
Logansport[2]	Cass	+1,075		2	Flows.	Several boring for gas; unsuccessful; sulphur water.
Loogootee	Martin	1,200				
Losantville	Randolph	1,105				For gas; unsuccessful.
McCordsville	Hancock					Gas well.
Madison[3]	Jefferson	1,004			—700	For gas; unsuccessful.
Marion[4]	Grant	+865-1,010	4		Flow.	Numerous gas wells; some yield oil.
Markle	Huntington	1,700	8		Flows.	White sulphur water.
Markleville	Madison	972				Gas well.
Martinsville	Morgan	1,472				For gas.
Do.[5]	do	668-704	5-6	30-35	Flow.	Six wells of mineral water.
Mechanicsburg	Henry					Gas wells.
Medaryville (6 miles west).[6]	Pulaski	1,030				Salt water and oil.
Michigan City	Laporte	819,833		300	+22	Temp., 57°. Sulphur water.
Michigan City (1 mile west).[7]	do	541				
Middleton	Henry	+935				Gas wells.
Mifflin[8]	Crawford	1,180				Some oil at 135 feet and some gas at 1,180 feet.
Millhousen	Decatur	1,000-1,100	6			Several gas wells.
Milroy						For gas; unsuccessful.
Millgrove	Jay	±925				Gas wells.
Mitchell	Lawrence	+1,200			—30	For gas; saline water at 1,200 feet.
Monon[9]	White	±920			Nearly to surface.	Salt water at 880 feet.
Do	do	+880			Nearly to surface.	Gas boring; salt water at 880 feet.
Monticello	do	+1,050			—550	Salt water at 1,050 feet.
Monrovia	Morgan	±1,500				
Montezuma	Parke	1,675	4	Many.	+115	Water at 450 and 1,100-1,200 feet.
Do	do	1,700		475	Rises to surface.	Salt water at 300 and 450 feet; sulphur water at 1,200 feet, which rose to +100 feet.
Monticello[9]	White	+1,150			—650	For gas; unsuccessful; salt water at 1,150 feet.
Montpelier[10]	Blackford	975			Flows.	Gas well; hard water.
Do	do	808				
Mooresville	Morgan	±1,500				
Morgantown	do	1,665	8		Nearly to surface.	Gas borings; fresh water at 70 and 490 feet; saline water at 1,100 feet.
Morristown[11]	Shelby	921			—421	Gas well; much salt water.
Mount Summit[12]	Henry	1,082			—720	Gas wells; salt water at 1,020 feet.

[1] Record, Ind. Agricultural and Geographical Repts., 1869, pp. 29-31.
[2] Record, Ind. Geol. and Nat. Hist., 19th Ann. Rept., 1894, p. 38; U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 732.
[3] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 723.
[4] Ibid., pp. 685-687.
[5] Record and analysis, U. S. Geol. Surv., 18th Ann. Rept., 1896-97, part 4, pp. 490, 498.
[6] Record, Ind. Geol. and Nat. Hist. Surv., 17th Ann. Rept., 1891, p. 315.
[7] Record, ibid. and U. S. Geol. Surv., 18th Ann. Rept., 1896-97, part 4, p. 491.
[8] Record, Ind. Geol. and Nat. Hist. Surv., 17th Ann. Rept., 1891, pp. 311-312.
[9] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, Part 1, p. 731.
[10] Ibid., p. 680.
[11] Ibid., p. 703.
[12] Ibid., p. 706.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Myers	Hamilton					Gas well; small product.
Muncie [1]	Delaware	870–955				Numerous wells in vicinity.
Do [2]	do	1,606			−506	Brine at 1,390 feet.
Nashville	Brown	500–530			Flows.	Two wells.
New Albany	Floyd					For gas; unsuccessful.
New Britton	Hamilton					Gas wells.
Newburg	Warwick	+400				
Newcastle [3]	Henry					Several gas wells with flows of salt water.
New Corner	Delaware					Gas well.
New Palestine	Hancock	1,060			−400	Salt water at 1,[illegible] feet; some gas at 625 and 900 feet.
Noblesville [4]	Hamilton	843–860				Gas wells.
North Madison	Jefferson	1,500	6	Many.	−200	
North Manchester [5]	Wabash	+1,180			−190	Gas boring; unsuccessful; salt water.
North Vernon [6]	Jennings	±1,460			±260	Do.
Oakville	Delaware					Gas well.
Ogden	Henry					Do.
Osgood	Ripley	950	5			Gas boring; small supply.
Oxford (5 miles SW)	Benton	537				
Palestine [7]	Hancock					Gas well.
Paoli	Orange	1,000				Sulphur water at [illegible] feet; salt water at 900 feet; lithia water at 1,000 feet.
Parker (1 mile north)	Randolph					Do.
Pendleton [8]	Madison					
Perkinsville	Madison					Gas well.
Peru [9]	Miami	900–1,050			To surface.	Boring for oil and gas.
Peru (2¼ miles north).[10]	do	1,042			−50	Salt water at 1,042 feet.
Petersburg	Pike	1,161				Blue lick water.
Do	do	1,200				Gas well.
Petersburg (one-half mile east).	do	1,310			Flows.	Salt water at 600 and 1,310 feet.
Petersburg (2¼ miles northeast).	do	1,200			−80	Salt water at 600 feet.
Petersburg (one-half mile north).	do	1,200	10–5¼	30	Flows.	Fresh water at 1[illegible] feet; salt water at 600 feet; oil at 1,2[illegible] feet.
Petersburg (1 mile north).	do	1,700	10–4		Flows.	Fresh water at 7[illegible] feet; some oil at 1,200 feet.
Pierceville	Ripley	965				For gas; unsuccessful.
Plainfield	Hendricks	1,355				Gas well.
Plymouth [11]	Marshall	+ 1,368			−468	For gas; unsuccessful.
Point Gabel	Grant					Gas well.
Portland [12]	Jay	900–1,500			−300	Gas wells; salt water at 1,500 feet.
Princeton	Gibson	600–790				Several wells.
Do	do	1,274				
Red Key	Jay	+900				Gas well.
Reelsville (near)	Putnam	2,600		Many.	Flows.	Sulphur water; no oil; temp., 60°.

[1] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, Part 1, pp. 713–719.
[2] Ibid., p. 731.
[3] U. S. Geol. Surv., 18th Ann. Rept., 1889–90, Part 1, pp. 705–707.
[4] Ibid., p. 697.
[5] Ibid., p. 739.
[6] Ibid., p. 723.
[7] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, p. 702.
[8] Ibid., p. 710.
[9] Record, Ind. Geol. and Nat. Hist. Surv., 16th Ann. Rept., 1888, p. 184; U. S. Geol. Surv., 11th Ann. Rept., 1889–90, Part 1, pp. 732–733.
[10] Record, Ind. Geol. and Nat. Hist. Surv., 16th Ann. Rept., 1888, pp. 185, 255.
[11] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889–90, Part 1, p. 735.
[12] Ibid., p. 681.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Reelsville (near)[1]	Putnam	1,240			+20	Salt and sulphur water.
Rensselaer	Jasper	800				Sulphur water.
Do	do	1,275				Gas boring; not in use.
Ridgeville	Randolph	981-1,105				Gas borings; unsuccessful.
Richmond	Wayne	945				Gas boring; unsuccessful.
Rochester[2]	Fulton	1,185				For gas; unsuccessful.
Do	do	500		Many.	+ 5	Sulphur water.
Rochester (1¼ miles south).	do	1,157			—15	Salt water at 1,157 feet.
Rochester	do	1,500				Water flowed at 240 feet; well abandoned.
Rockport	Spencer	+400				Four gas borings; no product.
Rockville	Parke	2,169				For gas; unsuccessful.
Rogers	Pike	1,785	10-4¼			
Royal Center[3]	Cass	+925				Oil wells.
Royerton	Delaware					Gas well.
Rushville and vicinity.[4]	Rush					Gas wells.
St. Omer	Decatur					Gas well.
St. Paul	Shelby	+820				Do.
Salem[5]	Washington	1,800				For gas; unsuccessful.
Do	do	750				Gas well.
Sandusky	Decatur	830	6		—15	
Selma[6]	Delaware	1,025				Do.
Seymour[7]	Jackson	1,090-1,204			Flows.	Several gas wells.
Do	do	500				Sulphur water.
Sharpsville[8]	Tipton					
Shelbyville[9]	Shelby					For gas; unsuccessful.
Shideler	Delaware					Gas well.
Sheridan	Hamilton	1,076				Do.
Shoals	Martin	960			Flows.	Some salt water.
Somerset[10]	Wabash	853				Water at 485 feet.
South Bend[11]	St. Joseph	1,670				For gas; unsuccessful.
Spencer	Owen	1,150	4	200	+65	Several wells; saline water.
Spiceland[12]	Henry					Gas wells.
Springport[13]	do					For gas; unsuccessful.
St. Marys	Vigo	2,055	8		—75	
Do	do	830	8		—75	
Sullivan	Sullivan	1,000			—15	Gas boring; much strong brine.
Sullivan, 2 miles SE	do	±1,000			Flows.	
Sullivan[14]	do	544				
Sulphur Springs	Henry					For gas; unsuccessful.
Summitville	Madison					
Do	do	1,000	8-6		At surface.	
Do.[15]	do	971			Flows.	Gas well; water at 140 feet.
Swainville	Hamilton			370		Gas well; small product.
Swayzee	Grant					Gas wells.
Sweetzer	do					Gas well.
Sycamore	Howard					Do.
Tampico	do	+950				Gas wells.

[1] Record Ind. Agr. and Geol. Rept., 1869, pp. 29-31.
[2] Record U. S. Geol. Surv., 11th Ann. Rept., 1889-90, Part 1, p. 733.
[3] U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 732.
[4] Ibid., p. 704.
[5] Ibid., pp. 725-726.
[6] Ibid., pp. 715-716.
[7] Ibid., pp. 726-727.
[8] Ibid., p. 969.
[9] Ibid., pp. 702-703.
[10] Record, Ind. Geol. and Nat. Hist. Surv., 17th Ann. Rept., 1891, pp. 252-253.
[11] Record, Michigan Geol. Surv., 1881-1893, p. 84, pl. 64; U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, pp. 734-35.
[12] Ibid., p. 707.
[13] Ibid., p. 706.
[14] Record, Ind. Geol. Surv., 1870, pp. 193-194.
[15] Record, U. S. Geol. Surv., 11th Ann. Rept. 1889-90, part 1, p. 709.

INDIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Terre Haute [1]	Vigo	2,800	8		Flows.	Sulphur water with little gas.
Do.[2]	do	1,793				Brine at 1,300 feet; sulphur water at 1,793 feet; some oil at 1,629 feet.
Do	do	±1,625				Several borings for oil; unsuccessful.
Thorntown	Boone	1,500	6	5	Flows.	For gas; unsuccessful.
Tipton [3]	Tipton	1,030				Small amount of gas.
Tobasso Landing	Floyd					Gas wells.
Trafalgar	Johnson	1,500				Dry well.
Treaty	Wabash	950	8-5			
Do.[4]	do	900	8-6		+8	
Union Grove	Delaware	944				Gas well.
Union City [5]	Randolph	1,093-1,780				Several borings for gas; unsuccessful.
Upland	Grant	1,040				Gas well.
Valley Mills	Henry					Do.
Valparaiso [6]	Porter	1,344				Do.
Do.[7]	do	1,336				For gas; unsuccessful.
Van Buren [8]	Grant	973				Gas well.
Vernon	Jennings	923				For gas; unsuccessful.
Wabash [9]	Wabash	2,270	6		−40	For gas; unsuccessful.
Waldron	Shelby	+820				Gas well.
Walnut Level	Wayne	+867				For gas; unsuccessful.
Walton	Cass	1,028				Salt water and some oil.
Warren	Huntington	969				Some oil; abandoned.
Warsaw [10]	Kosciusko	700		15		For gas; unsuccessful.
Do. [11]	do	1,437			−387	Salt water.
Washington	Wayne	+976				For gas; unsuccessful.
Waterloo	Dekalb					Gas well.
Westfield	Hamilton	1,080				Gas wells; much salt water.
Do	do	±1,068				Gas wells.
Williamsport	Warren	1,200			Flows.	Gas well; salt and fresh water also.
Winamac	Pulaski	1,200		45	do	For gas; unsuccessful; flow of water also.
Winchester [12]	Randolph	1,000-1,071				Several gas wells.
Windfall	Tipton	1,002				Gas well.
Worthington	Greene	1,445			Flows.?	Sulphur water.
Xenia [13]	Miami	937				Gas wells; flow of water also.
Do	do	936				Do.
Yorktown	Delaware	940				Gas well.
Zionsville [14]	Boone	1,038			−438	For gas; unsuccessful; salt water at 1,013 feet.
Do	do	800			Flows.	For gas; unsuccessful.

[1] Record, Ind. Geol. Surv. Report for 1870 (Indianapolis, 1871), pp. 126-134.
[2] Record, Ind. Geol. Surv. Report for 1870 (Indianapolis, 1871), p. 126; Ind. Agr. and Geol. Surv. Rept., 1869, pp. 28-29, 31; Am. Jour. Science, 2d series, vol. 48, p. 271.
[3] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-1890, part 1, pp. 695-697; Ind. Geol. and Nat. History Surv., 1885-1886, 15th report, p. 330.
[4] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-1890, part 1, p. 714.
[5] Ibid., p. 694.
[6] Ibid., p. 733.
[7] Record, Ind Geol. and Nat. History Surv., 16th Ann. Rept., 1888, p. 264.
[8] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-1890, part 1, p. 689.
[9] Indiana Geol. and Nat. Hist. Surv., Report for 1875, pp. 43-48.
[10] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 739.
[11] Ibid., p. 736.
[12] Ibid., pp. 683-685.
[13] Ind. Geol. and Nat. Hist., 16th Rept., 1888, p. 187.
[14] Record, U. S. Geol. Surv., 11th Ann. Rept., 1889-90, part 1, p. 730.

PRINCIPAL PUBLICATIONS RELATING TO DEEP BORINGS IN INDIANA.

The Natural Gas Field of Indiana, by A. J. Phinney, United States Geological Survey, Eleventh Annual Report, 1889–1890, part 1, pp. 579–740. Plates. Washington, 1891.

Water Resources of Indiana and Ohio, by Frank Leverett, United States Geological Survey, Eighteenth Annual Report, 1896–1897, part 4, pp. 423–559. Plates. Washington, 1897.

INDIAN TERRITORY.

Location.	Nation.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Bartlesville (2 miles distant).	Cherokee	1,800		Few.	Flows.	Small quantity crude petroleum.
Chelsea (5 miles W.)	do	300–600	8			Several oil wells.
Salina (1¼ miles SE.)	do	470			Flows.	Salt water.
Do	do	520			do	Do.
Chickasha	Chickasaw	876	10			Salt water at 298 feet; no water below; well in progress.
Atoka (15 miles W.)[1]	Choctaw	1,414				Small indications of oil at 807 feet; oil at 917 feet; much salt water; salt water and oil at 1,235 feet and 1,347 feet; oil and gas at 1,391 feet.

IOWA.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Ackley[2]	Hardin	920				
Algona[3]	Kossuth	1,050			−69	
Amana[4]	Iowa	1,640		100	+30	Temp. 60°.
Anamosa[5]	Jones	2,007	10–5	300	−56	
Anita	Cass	486		Many.		Coal prospect.
Atlantic[6]	do	1,310		do	−160	
Arcadia	Carroll	620				Failure.
Boone	Boone	3,016		Many.	−200	
Bedford	Taylor	425				Coal prospect.
Britt[7]	Hancock	984	7		−16	
Do	do	535	4½		−510	
Burlington	Des Moines	2,430	6–5	70	−38	
Calmar	Winneshiek	1,140	4	70	−320	
Do.[8]	do	1,223	3		−100	
Cedar Rapids	Linn	1,450	5	150	+14	3 wells.
Centervilie[9]	Appanoose	2,495	12–4	200	−260	
Do.[10]	do	1,540	14–7	350	−280	
Cherokee	Cherokee					
Clarinda	Page	1,002			Flowed.	Coal prospect.
Clinton[11]	Clinton	1,035–1,497	10–5	1,736	+68	5 wells.
Do.[12]	do	1,065	5½		+35	
Do.[12]	do	1,674	8–5	1,500	+45	
Council Bluffs[13]	Pottawattamie.	1,114				
Do.[14]	do	860				
Council Bluffs (school for deaf).[14]	do	1,091	4	56	+50	
Cresco	Howard	1,158				

[1] Record, Pa. 2d Geol. Surv. Reports, vol. I[5], p. 341.
[2] Record, Iowa Geol. Surv., vol. 3, pp. 189–192; vol. 6, pp. 219–220.
[3] Ibid., vol. 6, p. 196.
[4] Ibid., pp. 286–287.
[5] Ibid., pp. 262–265.
[6] Ibid., pp. 336–339.
[7] Analysis, Iowa Geol. Surv., vol. 6, p. 195.
[8] Record and analysis, ibid., pp. 191–192.
[9] Record and analysis, ibid., pp. 326–328.
[10] Record and analysis, ibid., pp. 326–328.
[11] U. S. Geol. Surv., 17th Ann. Rept., 1895–96, part 2, p. 811; analysis, ibid., p. 827.
[12] Ibid., p. 811; analysis, ibid, p. 827.
[13] Analysis, Iowa Geol. Surv. Reports, vol. 6, p. 340.
[14] Ibid., p. 340.

IOWA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Creston	Union	500-600				Two borings for coal: unsuccessful. Found water.
Des Moines[1]	Polk	3,000	10-3	400	—45	
Davenport (bottling works).[2]	Scott	780		300	+59	
Davenport (Malt and Grain Co).[3]	do	1,076	5	300	+13	Water from 1050-1076 feet.
Davenport (Gas Company).[3]	do	1,200	5-4	400	+47	Two wells. Water from near bottom.
Davenport (Glucose Co.).[4]	do	2,100-2,107	5		+77	Four wells.
Do.[5]	do	1,500	5	250	+54	
Davenport (city park).[6]		1,797	5	+125	—22	Water at 1,175 feet.
Davenport (Kimball House).[7]		1,080	5	120	+20	Water at 1,075 feet.
Davenport (packing company).[8]		1,180	8-5	250	+45	
Davenport (Schmidt building).[5]		1,200	4	73	+24	
Davenport (woolen mills).[6]		1,053	3¼	300	+35	Water from 700 and 1,050 feet.
Davenport (ice company).[5]		1,067	6-4	240	+10	Water from 775 and 1,064 feet.
Dubuque[6]	Dubuque	802	4			Water at surface.
Do.[9]	do	955	6	340	+81	Several wells of about this depth.
Do	do	1,262	6	450		
Do.[9]	do	1,954	3	40	+1	
Do	do	1,300-1,400	13	2,000	Flow.	Two wells.
Do.[10]	do	1,765	3	40		
Do.[9]	do	1,000	5	580	+41	Several wells 965-1,060 feet.
Emmetsburg[11]	Palo Alto	874			—34	
Do	do	810	6	42	—26	
Farmington	Van Buren	705				
Fontanelle	Adair	800		None.		Abandoned.
Fort Madison[12]	Lee	689	6	600	+20	
Do.[13]	do	720	6		+85	Temp. 55°.
Do.[13]	do	764	4		+20	
Glenwood[14]	Mills	2,000	10-4¼	83	—173	
Do.[14]	do	1,910		80	—5	
Granville	Sioux	450		Many.	150	
Greenfield	Adair	900		None.		Coal prospect.
Do	do	512		None.		
Grinnell[15]	Poweshiek	2,003	10-4	105	—230	
Grundy Center	Grundy	485			—150	
Holstein[16]	Ida	2,004	8-4		—275	
Homestead[17]	Iowa	2,224	10-4		—117	
Hull[18]	Sioux	1,230	10 6		—100	
Jefferson	Greene	2,021	8-5		—40	
Keokuk[19]	Lee	710	6	250	+35	Temp. 64°. Two other wells 700 feet deep.
Do.[20]	do	800	6		+47	Temp. 50°.
Do.[20]	do	2,000	12-10	3 wells 1,700	+30	Temp. 65°; 3 wells.

[1] Record, Iowa Geol. Surv. Reports, vol. 6, pp. 294-299.
[2] U. S. Geol. Surv., 17th Ann. Rept., 1895-1896, part 2, p. 812.
[3] Ibid., p. 812.
[4] Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 842.
[5] Ibid., p. 811.
[6] American Geologist, vol. 3, 1889, p. 117; Iowa Geol. Surv. Reports, vol. 6, pp. 272-280; Record U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, pp. 842-845.
[7] Record, U. S. Geol. Surv., 17th Ann. Rept., 1895-96, part 2, p. 844.
[8] Record and analysis, Iowa Geol. Surv. Reports, vol. 6, pp. 208-214.
[9] Ibid., pp. 208 214.
[10] Ibid., pp. 208 211.
[11] Record, ibid., p. 196.
[12] Record and analysis, Iowa Geol. Surv. Reports, vol. 6, pp. 321-322.
[13] Ibid., pp. 321 322.
[14] Ibid., pp. 340-347.
[15] Record and analysis, ibid., pp. 287-292.
[16] Record, ibid., p. 222.
[17] Record and analysis, ibid., pp. 283 285.
[18] Record, ibid. p. 199.
[19] Record and analysis, ibid, pp. 323-326.
[20] Ibid, pp. 323-326.

IOWA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Keokuk[1]	Lee	2,230	10	300	+30	Another well 1,805 feet; water also at 600 and 900 feet.
Do	do	1,987	6-4			
Do	do	935		Many.	Flow.	
Lakepark	Dickinson	700	4	55	−300	Temp. 50°.
Lansing[2]	Allamakee	676 740	6	700	+40	Two wells.
Le Mars[2]	Plymouth	1,560				
McGregor[3]	Clayton	1,006	6-3	20	+62	Temp. 54°.
Do.[3]	do	520	6-3		+20	Temp. 52°.
Manchester[4]	Delaware	1,870	10-5		−14	
Mason City	Cerro Gordo.	600	6-4	60	No flow.	Three wells.
Do	do	1,200	8	80	No flow.	
Do.[5]	do	1,473	8-6		−75	
Monota	Clayton	417	6	70	−212	
Do	do	452	6	None.		Abandoned.
Monticello[6]	Jones	1,198		175	−40	
Mount Clara[7]	Lee	939			−10	Formerly flowed 200 gallons.
Mount Pleasant[8]	Henry	1,125		165	−30	
Nevada	Story	940	11-6		−49	
Newton[9]	Jasper	1,400	5	Many.	−90	
Osceola	Clarke	1,953			No flow.	
Oskaloosa[10]	Mahaska	2,800-3,000				Abandoned.
Ottumwa[11]	Wapello	2,047	8	700	+108¼	Temp. 70°.
Do.[10]	do	1,554	10-4		+49¼	Temp. 64°.
Pella[12]	Marion	1,803	12-5	250	−90	
Pocahontas (3 miles south).	Pocahontas	632				Unsuccessful.
Pocahontas (near)	do	1,300		Many.		
Postville[13]	Allamakee	515	8¼		−300	
Redoak	Montgomery	560				Coal prospect.
Sabula[14]	Jackson	973		720	+78	
Sanborn	O'Brien	1,224	6	80	−459	
Saylorville	Polk	1,800				
Shenandoah	Page	700				
Sibley	Osceola	763	4¼	105	−200	
Sigourney[15]	Keokuk	1,880	6-4⅛		−30	
Sioux City[16]	Woodbury	2,011		3	Flows.	Water at 570 and rose to −12; at 1,250 feet flowed.
South English	Keokuk	420	4	None.		Abandoned.
Spencer	Clay	800	6	Many.		
Spencer	do	400				
Spencer (10 miles south).	do	600	4¼-3¼			Abandoned.
Tipton[17]	Cedar	2,700	8-4¼	Many.	−65	
Vinton[18]	Benton	1,287	6	62	+28¼	Temp. 56°.
Do.[19]	do	1,425	6	50	+28	Do.
Wall Lake	Sac	427				
Washington[20]	Washington	1,611	10-4¼	95	−54	
Do.[21]	do	1,217	12-6	62	−58	
Waukon[22]	Allamakee	577	8		−280	
Waverly	Bremer	1,720		Many.		
Webster City[23]	Hamilton	1,250	8-6	70	+16	
West Liberty[24]	Muscatine	1,768	6-4 7/16	1/12	Flows.	Temp. 65°.
Whatcheer	Keokuk	636				
Wilton Junction[25]	Muscatine	1,360	8-6	300	−78	
Bellville Township	Pocahontas	1,300				Abundant supply.

[1] Record, Iowa Geol. Sur. Reports, vol. 5, p. 200.
[2] Ibid., pp. 232-235.
[3] Record and analysis, ibid, pp. 185-188.
[4] Ibid., pp. 214-219.
[5] Ibid., pp. 193-195.
[6] Record and analysis, ibid., p. 256.
[7] Record, ibid., p. 322.
[8] Record and analysis, ibid., pp. 320-321.
[9] Record, ibid., p. 292.
[10] Ibid., pp. 308-310.
[11] Record and analysis, ibid., pp. 317-320.
[12] Record, ibid., pp. 310-315.
[13] Ibid., p. 189.
[14] U. S. Geol. Surv., 17th Rept., 1895-96, part 2, p. 817.
[15] Record, Iowa Geol. Surv. Reports, vol. 5, pp. 305-308.
[16] Record, Iowa Geol. Surv. Reports, vol. 5, p 258.
[17] Ibid., vol. 6, pp. 261-262.
[18] Ibid., vol. 3, pp. 192-195.
[19] Record and analysis, ibid., vol. 6, pp. 266-267.
[20] Record and analysis, Iowa Geol. Surv. Reports, vol. 6, pp. 304-305; Am. Geologist, vol. 1, pp. 28-31.
[21] Record and analysis, Iowa Geol. Surv., Reports, vol. 6, pp. 304-305.
[22] Record, Iowa Geol. Surv. Reports, vol. 6, p. 202, 1896.
[23] Record and analysis, ibid., pp. 220-222.
[24] Records and analysis, Iowa Geol. Surv. Reports, vol. 6, pp. 281-282.
[25] Ibid., pp. 280-281.

PRINCIPAL PUBLICATIONS RELATING TO DEEP BORINGS IN IOWA.

Iowa Geological Survey, volume 3, Second Annual Report, 1893, with accompanying papers, 502 pages, plates, Des Moines, 1895.

Artesian Wells of Iowa, by W. H. Norton, Iowa Geological Survey, volume 6 pages 113–428.

The Water Resources of Illinois, by Frank Leverett, United States Geological Survey, Seventeenth Annual Report, 1895–96, part 2, page 811.

KANSAS.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Alma	Wabaunsee	2,000				
Do	do	1,912	4–2¼		Flows.	Salt water and gas.
Anthony[1]	Harper	2,335				
Asherville	Cloud	638	3		−26	Salt water from 50 to 638 feet; mainly blue clay.
Atchison	Atchison	+1,197				
Banner	Trego	438	6	Few.	−150	All in shale.
Benedict (southeast of).	Wilson	2,414	13–6¼			Fresh water at 403 feet; strong salt water at from 1,096 to 2,414 feet.
Benedict (near)	do	827	8¼–5	¼		Oil well; fresh and salt water also found.
Bronson	Bourbon	850	8–6			Salt water at 650 to 700 feet.
Buffalo	Wilson	1,170				Only salt water.
Buffalo (2 miles west)	do	400–800				Oil and water wells.
Caldwell	Sumner	800	6			Salt water only at 457 feet.
Cawker City (2 miles northeast).	Mitchell	468			−217	Salt water.
Cawker City (10 miles north).	do	416			No flow.	Do.
Chanute[2]	Neosho	982				Several gas and oil wells.
Do	do	806	6¼–5			Large flow of gas; some water.
Cherokee	Crawford	913	7	500	−100	First water at 650 feet.
Cedarville	Smith					
Cherryvale	Montgomery	609–617				Gas wells.
Do.[3]	do	1,220	1¼		+8	Salt water, and gas found.
Do	do	1,397–1,500				Oil wells; water at several horizons.
Coffeyville	do	550				Gas well.
Columbus	Cherokee	1,304			−65	
Coolidge	Hamilton	500	5¼	90	Flows.	
Devon (near)	Bourbon	800	8–6			Salt water at from 650–700 feet.
Dodge City (1¼ miles east).	Ford	800				Unsuccessful.
Doniphan[4]	Doniphan	763				
Eldorado	Butler					Deep boring, salt water.
Elgin	Chautauqua	±1,400				Abandoned.
Elkader	Logan	408				
Elkader (7 miles S.)	do	500				Unsuccessful. All in blue shale.
Ellsworth	Ellsworth	1,300				Salt 730–880 feet; salt water at 1,300 feet.
Do	do	730	4¼		−114	Salt water.
Emporia[5]	Lyon	2,005	6			Gas prospect; abandoned.
Eminence	Finney					
Erie	Neosho	750		400		Mineral water.
Erie (2 miles north)	do	833		Many.	Flows.	Large flow of oil and gas, and salt water.

[1] Record, Kansas Univ. Geol. Surv. Rept., vol. 1, Pl. 21.
[2] Ibid., vol. 1, p. 77, pl. 13; vol. 3, pl. 25.
[3] Ibid., vol. 1, pl. 11; vol. 3, pl. 22.
[4] Record, Kansas Univ. Geol. Surv. Report, vol. 1, pl. 18.
[5] Ibid., vol. 3, pl. 28.

KANSAS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Erie	Neosho	813				Salt water at 400 feet; oil sand at 550-585½ feet.
Eureka [1]	Greenwood	503				Coal prospect; abandoned.
Do	do	+1,100				In progress 1900; salt water 500-700 feet, and 800-900 feet.
Fall River	do	986	10-5¼	1,000	−77	Water at 416 feet; salt water at 972 feet.
Do.[2]	do	1,480		Many.		
Farlington	Crawford	556				Small flow of gas.
Farlington (2 miles southeast).	do	551				Small flow of oil.
Fleming	do	1,005½	6	Many.	−118	Water also at 800 feet.
Fort Scott	Bourbon	620	5¼		Flows.	
Do	do	543	5¼	4	Flows.	
Fort Scott (near)	do	750	6½			Gas well; strong flow of water.
Do	do	850-900	8-6			Oil wells; salt water.
Fowler	Meade					
Fredonia [3]	Wilson	1,224				
Do	do	2,414		None.		Salt water at 354 and 1,195 feet; abandoned.
Garden City (one-half mile NW.).[4]	Finney	+1,000				
Do	do	902				
Garden City (8 miles south).	do	1,250				
Girard [5]	Crawford	500-550				Two gas wells.
Do	do	857-900	10	Many.	−150	
Girard (3½ miles N.)	do	401				Gas.
Goode (7 miles SE.)		430			−70	
Goodwater	Gove	501	3	Few.		All in shale; abandoned.
Greatbend (4 miles northeast).	Barton	1,365		10	+30	Saline water from Dakota sandstone, at 344 feet.
Hill City (3 miles from).	Graham	400			No flow.	Shale to bottom.
Horton	Brown	1,100	6	Few.		Water at 45 feet.
Howard	Elk	1,000		None.		Abandoned.
Do.[6]	do	1,226-1,410				
Hoyt	Jackson	1,206 or 1,406?	6	None.		
Humboldt [7]	Allen	793-962		Many.		Three water wells.
Do	do	937-970				Gas wells; water at 145, 218, 645 feet; salt water at 970 feet.
Hutchinson	Reno	+800				Several salt wells.
Independence	Montgomery	1,020				Oil and gas.
Iola	Allen	870				Large flow of gas.
Do [8]	do	734-737				Three wells.
Iola (near)	do	906	8½-5			Large flow of gas.
Do	do	928	5			Salt water found.
Do	do	976				
Ionia	Jewell	432				Salt water; abandoned.
Jamestown	Cloud				Flows.	Salt water found.
Jerome	Gove	400				
Jetmore	Hodgeman	1,000				For coal.
Do	do	700 or 800			−20-30	Not in use; abandoned.
Johnson	Stanton	400	8	Many.	−180	
Kanopolis	Ellsworth	881	8-4			Salt water at 645-875 feet.
Kansas City [9]	Wyandotte	758				
Kendall	Hamilton	500				No water at that depth.

[1] Record, Kansas Univ. Geol. Surv. Report, vol. 3, pl. 27.
[2] Ibid., vol. 1, pl. 12; vol. 3, pl. 24.
[3] Ibid., vol. 1, pl. 13; vol. 3, pl. 25.
[4] Ibid., vol. 2, p. 27.
[5] Ibid., vol. 3, p. 148.
[6] Ibid., vol. 3, pl. 29.
[7] Ibid., vol. 1, pl. 14; vol. 3, pl. 23.
[8] Ibid., vol. 1, pl. 15.
[9] Ibid., vol. 1, pl. 18.

KANSAS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Kincaid	Anderson	992				
Kingman	Kingman	+800				Salt shafts.
Kirwin	Phillips	514				
Lacrosse	Rush	444	3	20	−240	Water pure.
Laharpe[1]	Allen	990				
Larned	Pawnee	756		400		
Do	do	743	10–3	250	+50	Temp. 65°; salt water.
Lawrence	Douglas	600				Salt water.
Do	do	900				Gas and salt water.
Leavenworth[2]	Leavenworth	1,170			Flows.	Gas and water.
Do	do	2,116				
Liberal[3]	Seward	485	7	52	−130	Water at 130 feet.
Little River	Rice	1,000	8			Much water to 400 feet, then 600 feet of salt and shale.
Lone Elm	Anderson	1,140				Salt water at 320 feet, no gas or oil; abandoned.
Lovewell (3½ miles northwest).	Jewell	400				Salt water only.
Lyndon[4]	Osage	1,007				Salt water at 239 feet.
Lyons	Rice	1,230				Salt prospect; abandoned.
Lyons (Bemis Salt Co.).	do	1,625	8–5		−30	Salt well.
McFarland[5]	Wabaunsee	2,006	4			
Madison	Greenwood	1,896½	6			For gas; unsuccessful.
Mankato	Jewell	500	8		−50	Salt water.
Mapleton[6]	Bourbon	665				Water at 218 and 616 feet; oil at 647 feet, and salt water at 665 feet.
Marion	Marion	1,800				For coal; unsuccessful.
Marquette	McPherson	400	6	Few.	−70	Salt water.
Marysville	Marshall	1,360		Few.	Flows.	
Meade	Meade	800	6			Red beds at 200 feet; salt below.
Moran	Allen	1,008–1,085	12–4			Two holes; water to surface.
Mound Valley[7]	Labette	762	7 11/16–6⅛	1¼	+6	Temp. 70°. Salt water and gas.
Neodesha[8]	Wilson	1,101	8¼–5			Oil prospect. Water at 230 and 830 feet; salt water at 420, 685, and 775 feet, and gas at 655 feet.
Do	do	±2,400	8¼			
Do	do	1,310				
Do	do	2,414	6¼	Many.		Sulphur water at 1,423 feet; salt water below.
Neodesha (near)	do	1,078	6¼–5			Oil and gas wells. Water at 811 and 1,078 feet.
Neosho Falls	Woodson	1,205				Salt water at 361 feet.
Ness City (14 miles north).	Ness	656	3	30	−356	
Ness City (8 miles south).	do	±400	6			
Newton	Harvey	1,045				Prospect borings.
Do	do	910–1,076				Do.
Niotaze[9]	Chautauqua	1,158				Abandoned; flowed oil and water.
Oakley	Logan	725			−30	Unsuccessful: water at intervals to 200 feet, then shale to bottom.
Oberlin	Decatur	800–1,000		−¼		

[1] Record, Kansas Univ. Geol. Surv. Report, vol. 1, pl. 14; vol. 3, pl. 23.
[2] Ibid., vol. 1, pl. 20; vol. 3, pl. 26.
[3] Record, 51st Congress, 1st sess., Senate Ex. Doc. No. 222, p 158.
[4] Record, Kansas Univ. Geol. Surv. Report, vol. 3, pl. 27.
[5] Ibid., vol. 1, pl. 19; vol. 3, pl. 30.
[6] Ibid., vol. 1, pl. 16.
[7] Ibid., vol. 1, pl. 10; vol. 3, pl. 21.
[8] Ibid., vol. 1, pl. 11; vol. 3, pl. 22.
[9] Ibid., vol. 1, pl. 12; vol. 3, pl. 24.

KANSAS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Olathe	Johnson	600				Water at 85 feet; salt water at 530 feet; weak flow of gas at 361½ feet.
Osage Mission [1]	Osage	700				
Osborne	Osborne	500				
Oswego [2]	Labette	985	6		−100	Small amount of gas at 585 feet; salt water at about 610 feet.
Do	do	606			−40	Small amount of gas at 548 feet; salt water at 606 feet.
Ottawa	Franklin	1,002	8			Oil at 675 and 702 feet; large volume of gas.
Do	do	1,065				Salt water at 384 and 622 feet; fresh water at 715 and 755 feet; gas and water at 490 feet.
Paola [3]	Miami	1,075				City well.
Do	do	500-580	5¼-4¼	Many.	−0 to −400	Several gas wells
Parsons and vicinity.	Labette	500-1,050				Several wells for gas; not much found; salt water at 400 to 500 feet; no flow; abandoned.
Peru	Chautauqua	1,240-1,700				Three wells.
Peru (near)	do	1,190				Water at 660 and 1,190 feet.
Pittsburg	Crawford	950	7¼	75	−80	
Pleasanton	Linn	729	5			Salt water.
Do	do	918	6¼			Salt water at 828 and 918 feet.
Pleasanton (near) [4]	do	757	6¼-5			Water at 132 and 656 feet; salt water at 348 and 757 feet, and trace of oil at 353 and 730 feet.
Portis (6 miles northwest).	Osborne	546			No flow.	Salt water.
Portis (8 miles northwest).	do	543	6		−200	Do.
Pratt	Pratt	±800			−15	Thick salt beds 600 to 800 feet; not used.
Pyramids (near)		408	8		No flow.	Bad water.
Ransom	Ness	653	6-3	Several.	−60	Water in sandstone under blue shale.
Randolph	Riley	400				
Ravanna (north of)	Finney	+400		Many.	−200	Abandoned.
Do	do	+400			−45	Do.
Richfield [5]	Morton	670		22	Flows.	
Do	do	700		3	Flows.	
Do	do	600		6	Flows.	Temp. 66°; water at 570 feet.
Do	do	640		15	+25	Two wells; temp. 60°.
Rago	Kingman	1,000				Salt well; 175 feet of salt.
Russell	Russell	997	10-5	Many.	−300	Saline water.
St. Marys	Pottawatomie.	1,123			Flows.	Salt water.
Do	do	520			Flows.	Do.
St. Paul	Neosho	661-668			Flows.	Salty water; abandoned.
Santa Fe	Haskell	1,200	6	Many.	−200	Good water at 200 and 400 feet.
Do	do	1,300	10-5¼		−100	
Scandia	Republic	1,003			−16	Good water.
Smith Center	Smith	600	7		−390	Salt water at 590 feet; abandoned.
Smith Center (2 miles southeast).	do	540		Many.	−140	Salt water from sand 535-540 feet under 535 feet of shale.

[1] Record. Kans. Univ. Geol. Surv. Report, vol. 1, pl. 15.
[2] Ibid., pl. 10; vol. 3, pl. 21.
[3] Ibid., vol. 1, pl. 17.
[4] Ibid., pl. 16.
[5] Record, 51st Cong., 1st sess., Senate Ex. Doc. No. 222, p. 157.

KANSAS—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Sterling	Rice	916	10-2¼	None.		Salt well.
Do	do	946	10-2¼	Few.	—3	Do.
Stover	Labette	530	7		—16	
Sun (southwest of)	Barber	600				For coal: unsuccessful; mostly black shale.
Syracuse	Hamilton	1,000			—90	
Thayer	Neosho	825				Oil wells.
Thayer (near)	do	1,064	6¼-4¼			Water at 376, 575, 805, and 1,064 feet.
Do	do	895	8¼-6¼			Water at 215 feet; gas at 827-830 feet.
Tonganoxie	Leavenworth	854				City well.
Topeka[1]	Shawnee	900				
Do.[2]	do	1,638				Coal prospect: no coal; no flowing water.
Toronto[3]	Woodson	1,452			Flows.	Salt water and some oil.
Do	do	940-782				Two wells; some gas.
Tribune	Greeley	500				Unsuccessful.
Valley Falls	Jefferson	1,174	3	2	+40	Very saline water.
Wallace (vicinity)	Wallace	800	4	None.		Did not reach bottom of shales.
		448	7			
		400	7	None.		
Wamego	Pottawatomie	1,000			+6	Salt water.
Washington	Washington	1,100-1,200		1		
Do	do	1,350	6	None.		Abandoned.
Do	do	2,200	6	None.		Do.
Weir City	Cherokee	442	8¼	75	—70	
Do	do	480	7¼	75	—70	
Do	do	490	6¼		—70	
Wellington	Wabaunsee	1,000				Not in use.
Wichita	Sedgwick	1,605	14-4¼		—70	Salt water at 500 feet.
Do	do	1,025				
Wilson	Ellsworth	1,375	8-5			Salt water; abandoned.
Winfield	Cowley	1,200		Many.	+6	Salt water.
Yale	Crawford	1,217	6	Many.	—115	
Vulcan Iron Works	Kingman	1,000				Two salt shafts.
——	Trego	700				

PUBLICATIONS RELATING TO DEEP BORINGS IN KANSAS.

Report of J. W. Gregory, field agent for the Middle Division, Fifty-first Congress, first session, Senate Ex. Doc. No. 222, pp. 145-172. Washington, 1890.

Water Resources of a portion of the Great Plains, by Robert Hay, United States Geological Survey, Sixteenth Annual Report, 1894-95, part 2, pp. 535-588, plates. Washington, 1895.

The University Geological Survey of Kansas, by Erasmus Haworth and assistants, vol. 1. 320 pages, plates. Topeka, 1896.

Report of the Board of Irrigation, Survey, and Experiment for 1895 and 1896 to the Legislature of Kansas. 238 pages, plates. Topeka, 1897.

The University Geological Survey of Kansas, Special Report, by Erasmus Haworth and W. R. Crane, vol. 3. 347 pages, plates. Topeka, 1898.

[1] Record, Kans. Univ. Geol. Surv. Report, vol. 1, pl. 17.
[2] Ibid., vol. 3, pl. 27.
[3] Ibid., vol. 3, p. 149, pl. 29.

KENTUCKY.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gals.*	*Feet.*	
Ashland (4 miles south).	Boyd	1,715	13-10			For oil or gas; unsuccessful.
Ashland (6 miles south).	do	2,100	13-10			Do.
Atoka (1¼ miles west)[1]	Boyle	+1,414				Oil and gas.
Beaver Dam (1½ miles southeast).	Ohio	900				No oil or water; abandoned.
Blaine Creek mouth[2]	Lawrence	2,597				For oil or gas; unproductive.
Blaine Creek mouth (1½ miles from).[3]	do	1,840				Do.
Bowling Green[4]	Warren	1,782				But little oil, gas, or water.
Bowling Green (vicinity).[5]	do	600-1,200				Several prospects for oil or gas; some gas.
Bowling Green (15 miles northwest).	do	600-700				Several wells yielding heavy oil.
Boone's Landing[6]	Meade	500-579				Several gas wells.
Brooksville	Bracken	600				For oil or gas; in progress 1899.
Brummetts Station	Whitley	1,000	6		−5	Some gas at 300 feet.
Burkesville	Cumberland	1,700				Small showing of oil and gas.
Brandenburg[7]	Meade	400-765				Gas wells; some brine.
Catlettsburg (1 mile south).	Boyd	2,025	10-6½			Gas well.
Catlettsburg (1½ miles south).	do	2,322				For oil.
Cloverfork	Harlan	423	2			
Cloversport[8]	Breckinridge	+896				Several gas wells in vicinity; salt water at 400 feet, strong brine at 600 feet.
Cloyds Landing	Cumberland	±400				Oil well.
Cumberland Falls (vicinity).	Whitley	±400				Salt.
Cynthiana	Harrison	1,000-1,300			−8	Several wells.
Danville	Boyle	560	6			Unsuccessful.
Eddyville (below)	Lyon	1,815				Water 200 to 300 feet.
Elizaville	Fleming	600				For oil.
Frankfort	Franklin	825	6	Many.	Flows.	
Glasgow[9]	Barren	1,200				
Glasgow (5 miles southwest).[10]	do	1,370				Several gas wells.
Glasgow Junction (3 miles southeast).[11]	do	1,511				Salt water at about 700 feet.
Grand Rivers (near)	Lyon	1,315				Oil prospect; abandoned.
Grayson Springs (6 miles).[12]	Grayson	1,000	6	Many.	Flows.	Temp. 61½°.
Greenup (1½ miles east).	Greenup	940				Some oil at 400 feet; salt water at 500 feet; abandoned.
Greenup (1 mile)	do	+1,300				Some oil at 580 feet; abandoned.
Greenwood (2 miles southeast).	Pulaski	1,600				For oil, none found; abandoned.
Do	do	1,100				Abandoned.
Halsey (near)	Whitley	500	2			Coal prospect; some water at 60 feet.
Harrodsburg	Mercer	1,560	8		Flows.	Water at 1,100 feet; no gas.
Harrodsburg (near)	Jessamine	485	5			Water unfit for use.
Hartford	Ohio	1,000				Salt water.
Hartford (1½ miles northeast).	do	+1,300			Flows.	Gas and salt water.
Hawesville[13]	Hancock	±1,500				Salt water only.
Hazzard (near)[14]	Perry	+400				Salt well.
Henderson[15]	Henderson	+459				Coal prospect.

[1] Record, Pa. 2d Geol. Surv. Reports, vol. I[5], pp. 340-341.
[2] Record, ibid., pp. 335-336.
[3] Record, ibid., pp. 336-337.
[4] Ky. Geol. Surv., Petroleum and Natural Gas, etc., by E. Orton, pp. 159-160.
[5] Ibid., pp. 160-162.
[6] Ibid., pp. 176-177.
[7] Ibid., pp. 171-172, 176.
[8] Ibid., pp. 191-193.
[9] Ibid., p. 154.
[10] Record, ibid., p. 154.
[11] Record, ibid., pp. 155-156.
[12] Ky. Geol. Surv. Report, vol. 1, new series, p. 92.
[13] Ky. Geol. Surv., Petroleum and Natural Gas, etc., by E. Orton, p. 194.
[14] Record, Ky. Geol. Surv. Report, 1854-1855, pp. 36-39.
[15] Ibid., pp. 32-36; Ky. Geol. Surv., Petroleum and Natural Gas, etc., by E. Orton, pp. 195-196.

KENTUCKY—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Henderson[1]	Henderson	+900			Flows.	Brine.
Henderson (near)	do	1,024				Do.
Henderson (16 miles south).[2]	do	430 or 536				Two wells: one yields gas.
Hendricks	Magoffin	2,484	8-5			Some oil; no water below 825 feet.
Hood Creek[3]	Lawrence	1,625				Oil well.
Hopkinsville[4]	Christian	1,600				Some gas and oil at bottom.
Inez	Martin	2,200				
Do	do	950				For oil.
Keene	Jessamine	2,000				For oil 40 years ago.
Lagrange[5]	Oldham	1,500				Flow of salt water at 1,400 feet; no gas.
Do.[5]	do	1,200				Salt water at 1,200 feet; no gas.
Lagrange (1 mile south).[5]		565				Gas well.
Laurel[6]	Lawrence	1,625				Sulphur water at 1,007 feet.
——[7]	do	1,840-2,597				For oil or gas; unsuccessful.
Leatherwood Creek (mouth).[8]	Perry	410				Salt wells.
Lexington	Fayette	875	6			No water supply.
Louisa (20 miles west)[9]	Lawrence	2,105				For oil or gas; unproductive.
Louisa (9 miles southwest).[10]	do	2,407				Do.
Louisville (Dupont's).[11]	Jefferson	2,086	3	264	+170	Mineral water; temp. 86½° (or 76½°?).
Louisville (Phœnix Brewery).	do	1,800	8	Many.	+ 60	
Louisville (St. Patrick's).[12]	do	1,900		Many.	Flows.	Temp. 57.2°; salt water.
Louisville (Haynes's farm).[13]	do	1,000				Some gas at 400 feet.
Louisville (McGehee farm).[13]		1,000				No product.
Monticello	Wayne	200-700				Oil wells.
Morganfield[14]	Union	525	2			For oil; abandoned.
Morgantown	Butler	500				Oil, gas, and coal
Newport[15]	Campbell	2,007				Much water at 1,650 feet.
Owensboro[16]	Daviess	1,000	4			Brine at 765 feet; poor water below.
Do	do	1,480				Salt water at 780 feet; none below.
Do	do	1,200				
Owensboro (2 miles east).	do	1,000				But little gas.
Pactolus (near)[17]	Grayson	1,480			−100	For oil or gas; unproductive; much salt water at 1,475 feet.
Paducah[18]	Calloway	1,250				
Panola	Madison	1,700	4			Salt water at 150 and 1,700 feet.
Perryville	Boyle	650	6			For oil; unsuccessful.
Pineville	Bell	650				Oil well.
Smithland[19]	Livingston	1,200				Unsuccessful.
Smithland (Taylor farm).	do	+1,500				

[1] Ky. Geol. Surv., Petroleum and Natural Gas, etc., by E. Orton, p. 195.
[2] Ibid., p. 196.
[3] Record, Pa. 2d Geol. Surv. Reports, vol. I[5], p. 339.
[4] Ky. Geol. Surv., Petroleum and Natural Gas, etc., by E. Orton, pp. 162-165.
[5] Ibid., pp. 167-168.
[6] Record, Geol. Surv. Penn. Report I[5], Oil and Gas Region, p. 339.
[7] Record, ibid., pp. 335-339.
[8] Ky. Geol. Surv. Repts. 1854-1855, p. 228.
[9] Record, Pa. 2d Geol. Surv. Repts., vol. I[5], p. 338.
[10] Record, ibid., pp. 337-338.
[11] Record and analysis, Am. Jour. Sci., 2d series, vol. 27, pp. 174-178.
[12] Ky. Geol. Surv., Petroleum, Natural Gas, etc., by Orton, pp. 169-170.
[13] Ibid., p. 173.
[14] Ibid., p. 205.
[15] Record and analysis, Ohio Geol. Surv. Report 1888, vol. 6, pp. 298-300.
[16] Ky. Geol. Surv., Petroleum, Gas, etc., by Orton, p. 194.
[17] Record, Pa. Geol. Surv. Report I[5] on Oil and Gas Region, p. 340.
[18] Record, Ky. Geol. Surv. Description of Jackson Purchase Region, pp. 321-326.
[19] Ky. Geol. Surv., Petroleum, Gas, etc., by Orton, p. 198.

KENTUCKY—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Uniontown	Union	1,079	4		Flows.	For gas.
Uniontown (Davis mill).	do	+400	5-6		Flows.	Salt water.
Walton	Boone	±400				Gas well.
Warfield (near)[1]	Martin	+1,307				Do.
West Point (vicinity).[2]	Hardin	400				For gas; unsuccessful.
Whitesburg	Letcher	400				Salt wells.
Williamsburg (10 miles above).	Whitley	500	6			For oil; unsuccessful.
Williamstown	Grant	500				No water below 30 feet.

PRINCIPAL PUBLICATIONS RELATING TO DEEP BORINGS IN KENTUCKY.

Seventh Report on Oil and Gas Fields of Western Pennsylvania for 1887–88, by John F. Carll, Pennsylvania Second Geological Survey Reports, volume I[5], 356 pages, Harrisburg, 1890.

Kentucky Geological Survey Report for 1854–55, by D. D. Owen, Frankfort, 1856.

Occurrence of Petroleum, Natural Gas, and Asphalt in Western Kentucky, by Edward Orton, Kentucky Geological Survey Report, 1888–89, 232 pages, Frankfort.

LOUISIANA.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Aldenbridge	Bossier	400				
Alexandria	Rapides	735	10-6	276¼	+4	
Do	do	850				
Do	do	630				Four wells; temp. 85°±.
Allentown	Bossier	400				
Bosco City	Ouachita	400	6		−30	
Baton Rouge	East Baton Rouge.	1,000	6	243	−30	Water at 750 feet.
Do	do	760	10-6		Flows.	Temp. 70°; two wells
Bayou Sara	West Feliciana.	736	4	347	+2	Temp. 63°.
Do	do	450			+1	
Benton	Bossier	500				
Bolinger	do	500				
Boyce	Rapides	810		18	+15	Temp. 60°.
Colfax	Grant	1,103	2¼	42	+65	Temp. 62°; salty water; much gas.
Cote Blanche Island	St. Mary	450		104	−34	
Crawford	do	692	4	18	+2	Pumps 347 gallons; Temp. 62°; several other wells here.
Crowley	Acadia	635	4	312	−6	Pumps 312 gallons.
Delta	Madison	1,200				No water.
Dubach	Lincoln					Deep well.
Hammond	Tangipahoa	473	5	300	+12	
Lake Charles	Calcasieu	535	6-4	104	+18	Four wells; temp. 64°.
Lake Charles (2 miles east).	do	498	4	100	+10	
Do	do	510	6-4		Flows.	Two wells.
Do	do	500				
Lake City	Jefferson?	1,200				
Marksville	Avoyelles	800				

[1] Record, Pa. Geol. Surv. Report I[6] on Oil and Gas Region, pp. 339–340.
[2] Ky. Geol. Surv., Petroleum, Gas, etc., by Orton, pp. 180–181.

LOUISIANA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Minden	Webster	1,000			No flow.	
New Iberia	Iberia	600				
New Orleans	Orleans	1,200–1,000			+15	Several wells; temp. 68°.
New Orleans (Canal street).	do	3,000				Bored in 1856.
New Orleans	do	1,300				
Winnfield	Winn	1,100	8			Temp. 70°. Also gas

MAINE.

Augusta	Kennebec	570		10	No flow.	In granite.

MARYLAND.

Arbutus	Baltimore	775				Not finished.
Baltimore (National Brewery).	do	450	6	200	No flow.	
Baltimore (Maltby property).	do	900		Many.	No flow.	
Baltimore (Spring Garden Brewery).	do	500			No flow.	
Baltimore (Hannis Distillery).	do	800			No flow.	
Baltimore (Seawell)	do	562		None.		
Baltimore (Baumschmidt's Brewery)	do	400		25		
Baltimore (Von Der Horst's Brewery).	do	435	8	25	No flow.	
Baltimore (Brehm's Brewery).	do	1,300		120	No flow.	
Baltimore (Adler's Brewery).	do	800				
Bay Ridge	Anne Arundel.	470	6–4	20		Irony water.
Centerville [1]	Queen Anne	665		Many.	Near surface.	Water at 428 and [illegible] feet.
Claiborne [2]	Talbot	440	6	Many.		Water also at [illegible] feet.
Cumberland	Allegany	2,000	8	None.		Abandoned.
Crisfield	Somerset	1,018	3	Pumps 200.	Flows.	Flows 40 gallons; saline water.
Do	do	1,033	4	130	Flows.	Saline water.
Do.[3]	do	1,090	6		Flows.	Do.
Deer Park	Garrett	2,010	5		Flows.	
Easton	Talbot	600	3	None.		No water below [illegible] feet.
Elkton	Cecil	490	24			Water very unsatisfactory; temp [illegible]
Do	do	400				Abandoned.
Do	do	407				Unsuccessful.
Fort Washington						
Frederick	Frederick	1,140–996		70	+3	
Frestburg	Allegany	700	1¼	None.		Abandoned.
Indian Head	Charles	463	6	11	No flow.	
Salisbury [4]	Wicomico	424				Water at 267 feet.
Sparrows Point		495				No water below [illegible] feet.
Tilghmans Island	Talbot	370–420		Many.		4 wells.
Tunis Mills	do	430	2	Pumps 100.	Flows.	Flows 6 gallons

[1] Record, New Jersey Geol. Surv., Report for 1899, pp. 81–83.
[2] U. S. Geol. Surv., Bull. 138, p. 132.
[3] Record, U. S. Geol. Surv., Bull. 138, pp. 128–130.
[4] Record, New Jersey Geol. Surv., Report for 1899, pp. 113–115.

MASSACHUSETTS.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Boston (Eastern Cold Storage).	Suffolk	400	8	70	No flow.	
Boston (corner Huntington avenue and Gainesboro street).	do	512	8	Few.	No flow.	Bad water.
Boston (corner Commercial and Prince streets).	do	1,750			No flow.	
Boston (34 Providence street).	do	2,503	7¼		5	Sulphur water; good water 459-484 feet; well abandoned.
Boston (Park square)	do	2,567				No water below 500 feet.
Cambridge (Dow Soap Works).	do	500				Unsuccessful.
Cambridge (Morse and White streets).	do	462	6			Do.
Cambridge	do	400				Do.
Dalton	Berkshire	+400		Many.	No flow.	
Dorchester	Suffolk	870-900			No flow.	2 wells; water very salty.
Holyoke	Hampden	400	8	400	−20	
Do	do	800	8	600	−20	
Do	do	720	8	400	−14	
Do	do	1,005	8	Many.	No flow.	Water too irony.
Malden	Middlesex	650	8	65	No flow.	Water of fair quality.
New Bedford	Bristol	510	6	2½	No flow.	
North Adams	Berkshire	500	8	625	−4	Very hard water.
Northampton	Hampshire	3,710	8	7	No flow.	Not successful.
Do	do	4,022				Do.
Princeton	Worcester	900		Few.		
Roxbury	Suffolk	502	6		−20	
Do	do	403				
Stockbridge	Berkshire	650	8			Do.
Taunton	Bristol	975	8	52	−12	Water too irony.
Turners Falls	Franklin	900	6		No flow.	Water too hard.
Walpole	Norfolk	1,000		15		
Waltham	Middlesex	460		Very few.	No flow.	
Watertown	do	700		Many.		
West Cummington	Hampshire	625	8	2½	No flow.	Water too irony.

MICHIGAN.

Adrian [1]	Lenawee	1,650				Mineral water at 805 feet. Abandoned.
Albion	Calhoun					Several wells.
Algonac [2]	St. Clair	1,614				Salt well.
Algonac (5 miles below).[3]	do	1,727				Do.
Allegan [4]	Allegan	1,275-1,400				Several borings for oil; not much found.
Alma [5]	Gratiot	2,863			−2	
Alpena	Alpena	650	5	200	+20	Temp. 52°. Several wells.
Do [6]	do	1,026-1,269				Several salt wells.
Ann Arbor [7]	Washtenaw	770 or 775			−40	
Assyria	Barry	1,850				For oil; unsuccessful.
Battlecreek [8]	Calhoun	440			−16	Water at 116 feet only.
Banks	Bay	774-980				Salt wells.
Bay City	do	715-1,200				Numerous salt wells in vicinity.
Bay City [9]	Bay	505				Salt wells in upper salt beds.
Do	do	1,600				

[1] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 44, pl. 1.
[2] Ibid., pl. 3.
[3] Ibid., pl. 2.
[4] Ibid., pp. 44-45, pl. 4.
[5] Analysis, ibid., pp. 45-46; U. S. Geol. Surv. Water Supply and Irrigation Paper, No. 31, p. 83.
[6] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, pp. 46-47, pl. 5.
[7] Ibid., pp. 47-49; Reports, 1873-1876, vol. 3, part 1, p. 92.
[8] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 50.
[9] Analysis, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 182.

MICHIGAN—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Bay City[1]	Bay	2,865				Brine at 2,141-2,[illegible] feet.
Benton Harbor[2]	Berrien	1,205				
Do	do	1,400	10-6	Many.	−30	
Big Rapids	Mecosta	1,360		Many.	−30	Mineral water.
Blackmar	Saginaw	1,764				Salt well.
Carrollton	do	743-800				Several salt wells.
Casewell[3]	Thuron	1,735-1,770				Salt wells.
Chadwick	Ionia	498				
Charlevoix[4]	Charlevoix	400-482	8		Flow.	Temp. 46°.
Charlotte[5]	Eaton	2,209	6		−20	
Do	do	730				
Cheboygan[6]	Cheboygan	700				
Do	do	452	10-8		To surface.	
Coldwater (west of)[7]	Branch	447				Water at 223 feet: brine at 282 feet.
Do.[8]	do	1,200				
Constantine[9]	Saint Joseph	680				Strong brine at 382 feet.
Do.[10]	do	+1,080				
Corunna[11]	Shiawassee	907				
Detroit (9 miles northeast).[12]	Wayne	770				Some gas and water at 165 feet.
Dowagiac	Cass	1,500				Unsuccessful.
Do	do	2,200				Water at 87 feet: brine at 387 feet
Do.[13]	do	1,760				
Do	do	2,300				Water at 90 feet: brine at 780 feet
East Saginaw[14]	Saginaw	806				Salt well.
East Tawas[15]	Iosco	905				Do.
Essexville[16]	Bay	755				
Flint[17]	Genesee	1,200				Salt well: fresh water at 260 feet.
Florence	Saint Joseph	800				Salt wells.
Forestville	Sanilac	505-600				Abandoned and filled up.
Fountain Point	Carp Lake, Leelanau.		8		+15	
Frankfort[18]	Benzie	1,800				
Do.[19]	do	2,200		160	Flows.	Temperature 5[illegible]°: mineral water.
Grand Marais	Alger	1,215		None.		Abandoned.
Grand Rapids[20]	Kent	2,200				Fresh water with gas and brine at bottom.
Do	do	(?) 700				
Grindstone	Huron	1,080				Abandoned.
Hillsdale[21]	Hillsdale	1,350-1,550				Brine at 1,100 feet.
Howell	Livingston	550				Gas: abandoned.
Imlay[22]	Lapeer	1,020				Fresh water at 190 to 200 feet: salt water at 648 to 710 feet.
Ionia	Ionia	400-600	8	Many.	+ 7	No water below 362 feet: temperature 55°.

[1] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 50, pl. 6.
[2] Ibid., p. 51, pl. 7.
[3] Ibid., p. 53; Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 94.
[4] U. S. Geol. Surv. Water Supply and Irrigation Paper, No. 30, p. 87.
[5] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 53, pl. 8.
[6] Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 53.
[7] Record, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 87-88.
[8] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 54, pl. 10.
[9] Record, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 93.
[10] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 54, pl. 11.
[11] Ibid., p. 54, pl. 12.
[12] Ibid., p. 54, pl. 15.
[13] Ibid., p. 55, pl. 16.
[14] Ibid., p. 55; Mich. Geol. Surv. Reports, 1873-1576, vol. 3, part 1, pp. 94-96; Analysis, p. 183
[15] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 57; Analysis, Mich. Geol. Surv Reports, 1873-1876, vol. 3, part 1, p. 184.
[16] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 58.
[17] Ibid., p. 58; Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 97.
[18] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 59, pl. 18.
[19] Analysis, ibid., p. 59.
[20] Record, ibid., p. 61, pl. 20.
[21] Ibid., p. 62; Mich. Geol. Surv. Reports, 1883-1876, vol. 3, part 1, p. 81.
[22] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 63, pl. 22.

MICHIGAN—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Ionia [1]	Ionia	450				Flow of sweet water at 300 feet.
Ithaca [2]	Gratiot	637	8	50	−72	Several wells; good water.
Jackson [3]	Jackson	2,100–2,455			Flows.	Several wells Flow of water at 1,050 feet; hot water at 1,820 feet.
Do	do	2,700				Abandoned.
Do	do	206–400	10	Many.	−9	Large water supply; several wells.
Kalamazoo [4]	Kalamazoo	2,250				
Kawkawlin [5]	Bay	810–1,133				Two salt wells.
Lake Linden	Houghton	1,502–1,508	12–8	100		
Lansing "magnetic well."	Ingham	1,400		1	Flows.	Saline water. Temperature 58½°.
Lansing Hotel	do	740				
Lansing Reform School. [6]	do	506				
Ludington [7]	Mason	2,220				
Do. [8]	do	1,650				
Ludington (1 mile south). [9]	do	2,260				
Manistee [10]	Manistee	1,947–2,027				Numerous salt wells in town and vicinity. Black water at 960. Some oil at 1,905 feet.
Do	do	2,015	10–5		−15	Two salt wells.
Marengo [11]	Calhoun	460				
Marine City [12]	St. Clair	1,470–1,737				Several salt wells in and near town.
Marine City (city well). [13]	do	1,777			Flows.	Clear water 1,170–1,370 feet.
Marshall [14]	Calhoun	440			Flows.	
Maryville [15]	St. Clair	1,150				Salt water at 745 feet; mineral water 970 and 985 feet.
Melbourne	Saginaw	950				
Menominee	Menominee	+400				
Midland [16]	Midland	1,300–1,325				
Monroe [17]	Monroe	1,765	8	Several.	+ 4	Well now plugged; water somewhat sulphurous.
Mount Clemens [18]	Macomb	1,060–1,244				Several mineral wells.
Muskegon [19]	Muskegon	1,230				Flows of mineral water at 333 feet and 643 feet.
Do. [20]	do	2,627				Strong flow of mineral water at 700 feet, brine at 2,400 feet.
New River [21]		1,029				Salt well.
Niles	Berrien	1,438	10–5	15	+15	Temperature 60°.
Do. [22]	do	1,140				

[1] Record, Mich. Geol. Surv. Reports, 1873–1876, vol. 3, part 1, pp. 134–135.
[2] Record, Mich. Geol. Surv. Reports, 1881–1893, vol. 5, part 2, pp. 63–64.
[3] Ibid., p. 65, pls. 23–25.
[4] Record, Mich. Geol. Surv. Reports, 1881–1893, vol. 5, part 2, p. 65, pl. 26.
[5] Ibid., p. 65; Mich. Geol. Surv. Reports, 1873–1876, vol. 3, part 1, p. 96.
[6] Record, Mich. Geol. Surv. Reports, 1873–1876, vol. 3, part 1, pp. 117–118.
[7] Record, Mich. Geol. Surv. Reports, 1881–1893, vol. 5, part 2, p. 66, pl. 27.
[8] Ibid., pl. 29.
[9] Ibid., pl. 28.
[10] Ibid., p. 66, pls. 30–32.
[11] Ibid., p. 67.
[12] Ibid., p. 67, pls. 33–38.
[13] Ibid., p. 67, pl. 39.
[14] Ibid., p. 67.
[15] Ibid., p. 68, pl. 40.
[16] Record, Mich. Geol. Surv. Reports, 1881–1893, vol. 5, part 2, p. 69.
[17] Ibid., p. 70, pl. 41.
[18] Record, and analysis, ibid., pp. 70–71, pl. 42.
[19] Record, ibid., p. 71, pl. 43; Mich. Geol. Surv. Reports, 1873–1876, vol. 3, part 1, p. 84.
[20] Ibid., p. 85.
[21] Ibid., p. 77; Mich. Geol. Surv. Reports, 1881–1893, vol. 5, part 2, p. 73.
[22] Record, Mich. Geol. Surv. Reports, 1881–1893, part 2, p. 73, pl. 44.

MICHIGAN—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Niles [1]	Berrien	600				Strong brine at 370 feet.
Norris	Wayne	631				For gas; abandoned.
Oscoda [2]	Iosco	1,070-1,103				Salt wells.
Owosso [3]	Shiawassee	1,000				Brine at 634 feet.
Petoskey	Emmet	575	10-8	450	+18	Temperature 50°.
Pontiac [4]	Oakland	1,505				Salt water at 1,100 feet.
Port Austin [5]	Huron	1,198-1,225				Salt wells; sweet water at 336 to 1,100 feet.
Port Hope [6]	do	787				Salt well.
Port Huron [7]	St. Clair	498-785				Gas wells.
Port Huron (12 miles northwest).	do				Flows.	
Port Huron [8]	do	1,700				Gas and salt.
Port Huron Deer-spring.	do	745			-150	Slightly mineral water.
Portsmouth	Bay	1,000				
Do. [9]	do	664				Salt well.
Provemont	Leelanau	700	8		+ 10	Sulphur water 30 feet in rock.
Romeo [10]	Macomb	1,600			-600	
Royal Oak [11]	Oakland	1,400				
Do. [12]	do	2,502				
Saginaw	Saginaw	741-830				Numerous salt wells.
Do. [13]	do	860				
Saginaw (southeast). [14]	do	1,764				Brine at 350 and 1,655 feet.
St. Clair [15]	St. Clair	919				Salt wells.
Do. [16]	do	1,662			-300	Salt well.
St. Ignace [17]	Mackinac	919	8	Many.	Flows.	Strong sulphur water.
St. Johns	Clinton	1,200				Unsuccessful.
St. Louis	Gratiot					Deep well.
Salsburg	Bay	1,000-1,013				Several salt wells.
Sandbeach [18]	Huron	702				Salt well.
Do. [19]	do	1,920				For gas; unsuccessful.
Stronach [20]	Manistee	1,972				
Tawas City [21]	Iosco	905				Salt well.
Thunder Bay River (near bed). [22]		1,025				Salt well. Flow of mineral water at 400 feet.
Whiterock [23]	Huron	555-1,311				Several salt wells.
Winona	Bay	1,020				Drill hole for copper ore.
Wyandotte [24]	Wayne	2,500				Abandoned.
Do	do	600-800				Numerous salt wells.
Ypsilanti	Washtenaw	808				
Zilwaikee [25]	Saginaw	800-860				Several wells.

[1] Record, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 93.
[2] Analysis, ibid., p. 186.
[3] Record, ibid., p. 97; Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 78, pl. 45.
[4] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 75, pl. 47.
[5] Ibid., pp. 75-76; Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, pp. 77-78; Analysis, p. 183.
[6] Ibid., p. 76.
[7] Ibid., p. 77, pls. 48-55.
[8] Ibid., pp. 77, pl. 57.
[9] Analysis, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 182.
[10] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 78, pl. 59.
[11] Ibid., p. 79.
[12] Ibid., p. 79, pl. 60.
[13] Ibid., p. 79; Analysis, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 182.
[14] Record, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, pp. 96-97.
[15] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 79, pl. 62.
[16] Ibid., pl. 61.
[17] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 79, pl. 63.
[18] Analysis, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 184.
[19] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, pp. 81-82.
[20] Record, ibid., p. 84, pl. 65.
[21] Record, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 79.
[22] Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 40.
[23] Ibid., pp. 76-77; Analysis, p. 184; Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 85.
[24] Record, Mich. Geol. Surv. Reports, 1881-1893, vol. 5, part 2, p. 87, pl. 66.
[25] Analysis, Mich. Geol. Surv. Reports, 1873-1876, vol. 3, part 1, p. 185.

PUBLICATIONS RELATING TO DEEP BORINGS IN MICHIGAN.

The Geology of Lower Peninsular of Michigan, by C. Rominger, Michigan Geological Survey, vol. 3, part 1, 225 pages, New York, 1876.

The Geology of Lower Michigan with reference to deep borings, etc., by A. C. Lane, Michigan Geological Survey, Vol. 5, part 2, 100 pages, plates, Lansing, 1895.

Analysis of many of the well waters are in "Lower Michigan Mineral Waters," by A. C. Lane, U. S. Geological Survey, Water-Supply and Irrigation Papers, No. 31, Washington, 1899.

Water Resources of the Lower Peninsular of Michigan, by A. C. Lane, U. S. Geological Survey, Water-Supply and Irrigation Papers, No. 30, 97 pages, plates, Washington, 1899.

MINNESOTA.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Austin	Mower	750	10-8	220	−6	Fine water from 600 feet.
Belle Plaine	Scott	710				
Benson	Swift	478				
Blue Earth	Faribault	1,300			−30	
Do	do	1,240		Many.	−30	
				5	×200	First flow at 420 feet; second flow at 425 feet.
Browns Valley [1]	Traverse	465				
Brownsville [2]	Houston	590		1,000	+13	
Dodge Center	Dodge	504	8	80	−88	Railroad well.
Duluth (12 miles west).[3]	St. Louis	1,507	8-5		−40	Mineral water at 1,225 feet.
East Minneapolis [4]	Hennepin	1,421				
Elk River	Sherburne	513		Many.	+4	Several wells in vicinity; only flow is at 308 feet.
Faribault	Rice	520				Signs of gas.
Fond du Lac	St. Louis	1,508			−10±	Salty water; bored for gas.
Fountain	Fillmore	579	6	20	−225	
Freeborn	Freeborn	950				Unsuccessful.
Gladstone	Ramsey	615			−30	
Glencoe	McLeod	1,640	8-6	50	−85	
Do	do	1,000		50		
Graceville	Bigstone	460	8-6	40	−50	Two wells; granite at 510 feet.
Grove City	Meeker	700			−57	
Hastings [5]	Dakota	1,160		100	+14	Water slightly salty.
Hayfield		530		None.		
Henderson	Sibley	707	10-8	400	+70	Temp. 50°.
Humboldt [6]	Kittson	644				Salty water at 170-180 feet.
Jordan	Scott	650?				
Kandiyohi	Kandiyohi	450				Unsuccessful.
Lake City [7]	Wabasha	820				
Lamberton	Redwood	400				
Mankato	Blue Earth	2,204			−90	Unsuccessful.
Do	do	650	10, 8, 6	500 to 80	+40	Several wells. Water ferruginous.
Mendota [8]		857	4	10	+10	
Minneapolis	Hennepin	1,431				Several wells unsuccessful.
Minneapolis (Lakewood Cemetery) [9]	do	2,150				
Minneapolis (West Hotel).[10]	do	622		300	−24	Water at 168 feet.
Minneapolis (C. M. and S. P. R. R. shops).	do					

[1] Record, Minn. Geol. Surv., 14th Rept., 1885, p. 14. Report Special Comm. U. S. Senate on Irrigation and Reclamation of Arid Lands, vol. 4, Washington, 1890, p. 48.
[2] Record, Minn. Geol. Surv., 13th Rept., 1884, p. 59. Report Special Comm. U. S. Senate on Irrigation and Reclamation of Arid Lands, vol. 4, Washington, 1890, p. 48; Minn. Acad. Natural Sciences Bull., vol. 3, No. 1, p. 142.
[3] Record, Minn. Geol. Surv. Bull. 5, Gas in Minnesota, pp. 31-35.
[4] Record, Minn. Geol. Surv. Report, vol. 5, 1876, pp. 154-156.
[5] Record, Minn. Geol. Surv., 13th Rept., 1884, pp. 56-57; Analysis and Record Minn. Acad. of Natural Sciences Bull., vol. 3, No. 1, pp. 137-141.
[6] Record and analysis, Minn. Geol. Surv., 13th Rept., 1884, pp. 42-47.
[7] Record, ibid., p. 58; Minn. Acad. Natural Sciences Bull., vol. 3, No. 1, p. 142.
[8] Record, Minn. Acad. Natural Sciences Bull., vol. 3, No. 1, p. 141; Minn. Geol. Surv., 13th Rept., 1884, pp. 55, 56.
[9] Ibid., pp. 137-138; ibid., pp. 50-54.
[10] Analysis, ibid., p. 137; Record, Minn. Geol. Surv., 14th Rept., 1885, p. 11.

MINNESOTA—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Minneapolis (Soldiers' Home).	Hennepin					
Minneapolis (Winslow House.	do	1,421			No flow.	Abandoned.
Minneopa Falls [1]	Blue Earth	1,000	8-6			Flow at 540 feet, and salty water at 940 feet; granite at 940 feet.
Monticello	Wright	500			−18	Good water.
Moorhead [2]	Clay	1,901				Water at 120, 135, and 370 feet.
Do.[3]	do	1,425				Water at 120 feet and 1,425 feet.
New Germany	Carver	410	3			Water at 100 feet only.
Northfield	Rice	647	8	1,000	+25	Hard water. Supply is from 300 feet.
Owatonna	Steele	640	8	250	− 8	
Pine City		700	12-4½	75	−70	
Pipestone	Pipestone	537				
Plainview	Wabasha	690	12	100		
Redwing [4]	Goodhue	500	6	100	+75	Flows from 190-450 feet.
St. Charles	Winona	944			−60	
St. James	Watonwan	501	10-8	300	−27	Hard water.
St. Paul (G. N. R. R.)	Ramsey	834			−38	
St. Paul (Elevator Co.).[5]	do	850			−35	
St. Paul (St. P. & D. R. R.)	do	750				
St. Paul Transfer Railroad.	do	575				
St. Paul (West. M. and N. W. R. R.).	do	1,030			−24	
St. Paul city well	do	1,065				
St. Paul (harvester works).[6]	do	871½				
St. Paul, Wilgus well	do	625				
St. Paul Fair Grounds	do	500				
St. Paul, Lake Vadu-ais.	do	728½			−11	
St. Paul, White Bear Lake.	do	777			−18	
St. Vincent (2 miles northwest).[7]	Kittson	1,037				
Scott	Stevens	+400				No water.
South St. Paul	Ramsey	487			−5	
Do	do	3,000				For gas.
Stephen	Marshall					No success.
Stillwater [8]	Washington	3,500	5			For gas, unsuccessful: water at 162 and 300 feet: some salt water at 1,950 feet and some gas at 2,250 feet.
Tower (2 miles east).	St. Louis	400	1½	Many.		Diagonal drill hole in gneiss.
Tracy [9]	Lyon	724			−37	
Do	do	597			−148	
Tyler	Lincoln	+400				
Do	do	+600				
Walnut Grove	Redwood	400				
Waseca	Waseca	1,157	10-8	200	−120	
White Bear	Ramsey?	777			−15	
Winona	Winona	478	6	500	+10	Temp. 54°; cased 175 feet.
Worthington	Nobles	600				Unsuccessful.
Wyoming	Chicago	505	8-6	Many.	−13	

[1] Record, Minn. Geol. Surv. Bull. 5, Gas in Minnesota, pp. 23-24.
[2] Report on Irrigation, 52d Congress, 1st session, Senate Ex. Doc. No. 41, part 2, pp. 72-74. Washington, 1893.
[3] Record, Report of Special Comm. U. S. Senate on Irrigation and Reclamation of Arid Lands, vol. 4, p. 48, Washington, 1890; Minn. Geol. Surv. Bull. 5, Gas in Minnesota, pp. 27-31.
[4] Record Minn. Acad. Natural Sciences Bull., vol. 3, No. 1, p. 142; Minn. Geol. Surv., 13th Report, 1884, pp. 57-58.
[5] Record, Minn. Geol. Surv., 13th Rept., 1884, p. 63; Minn. Acad. Natural Sciences Bull., vol 3, No. 1, p. 140.
[6] Ibid., pp. 59-63; ibid., p. 140.
[7] Record, Minn. Geol. Surv., 14th Rept., 1885, p. 15.
[8] Record, Minn. Geol. Surv. Bull. 5, Gas in Minnesota, pp. 25-27; Am. Geologist, vol. 3, p. 343.
[9] Record, Minn. Geol. Surv., 14th Rept., 1885, pp. 351-352.

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Minnesota Geological Survey, Thirteenth Annual Report, for 1884, by N. H. Winchell, 196 pages, plates, St. Paul, 1884.

Minnesota Geological Survey, Fourteenth Annual Report, for 1885, part 1, by N. H. Winchell, 165 pages, St. Paul, 1886.

Minnesota Academy of Natural Sciences Bulletin, Vol. III, No. 1, Proceedings and Accompanying Papers, 1883–1886, by C. W. Hall, 160 pages, plates, Minneapolis, 1889.

Minnesota Geological Survey Bulletin No. 5, Natural Gas in Minnesota, by N. H. Winchell, 39 pages, St. Paul, 1889.

Report of the Special Committee of the United States Senate on the Irrigation and Reclamation of Arid Lands, vol. 4, 386 pages, Washington, 1890.

MISSISSIPPI.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Artesia (44½ miles south).	Lowndes	700	4-3	10	−90	
Bay St. Louis	Hancock	400-760	4½-2	100-5	Flow.	Many wells. Temperature of deeper wells 78°.
Biloxi	Harrison	850				
Bigbee Valley	Noxubee	±500			Flow.	
Bonhomie	Perry	650			−30	
Brookville	Noxubee	680		10	−75	
Canton	Madison	1,021	8-3	90	+10	Temp. 74°.
Cliftonville	Noxubee	±500			Flow.	Three wells.
Columbus	Lowndes	400		Each 80	Flow.	Two wells; temperature 70°.
Ellisville	Jones	1,160	3			No water below 650 feet.
Forest	Scott	520			−90	Water at 220 feet, court-house well.
Greenwood	Leflore	400			+40	Three wells.
Do	do	506	6	400	−45	
Do	do	400			+40	Twenty wells in adjoining region.
Gulfport	Harrison	700	4½-2	80	+25	Temp. 71° ±.
Houston	Chickasaw	1,500	3	Few.	−50	
Indianola	Sunflower	800				Unsuccessful.
Jackson	Hinds	1,200		Many.		
Do	do	604		Many.		
Longview	Oktibbeha	936	10	25	−5	
Moorhead	Sunflower	950	3		+50	
Mechanicsburg	Yazoo	620			−40	
Macon	Noxubee	763			Flows.	Two wells.
Okolona	Chickasaw	600			−65	
Prairie Rock	Noxubee	±600			Flows.	Several wells.
Ravine	do	700		10	−25	
Ripley	Tippah	600	10-8		−25	
Revive	Madison	720			−20	
Satartia	Yazoo	588	3	15	+4	
Scranton	Jackson	774	6	700	+45	Temp. 74°.
Do	do	750	3		Flows.	
Do	do	780	6			
Do	do	727	2			
Tchula	Holmes	800			Flows.	Two wells.
Do	do	456	2		+16	
Do	do	470			Flows.	
Vicksburg	Warren	1,060		Few.	Flows.	
Wesson	Copiah	1,300				Unsuccessful.
Do	do	1,400				
Yazoo City	Yazoo	635			+20	
Do	do	500	3		−140	
Do	do	475	4	40	+5	Two wells.
Do	do	740				
Do	do	800				
Do	do	1,254				
Yazoo City (18 miles southeast).	do	588			−130	
Yazoo City (25 miles southwest).	do	588	2	14	+12	Temp. 70°.
Yazoo City (4 miles west).	do	696	2		+9	

MISSOURI.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Annapolis (near)		663-400				Several prospect holes.
Bartlett	Shannon	+400				
Do	do	740	6	70	−340	
Baryties	Washington	495				Abandoned.
Bethany	Harrison	654	3¼	5	Flows.	Temp. 47°.
Bethel (4 miles north)	Shelby	450	6	1	−90	
Birchtree	Shannon	+400				
Boonslick [1]	Howard	1,008	3	Many.		
Booneville	Cooper	403	6		−78	Water strongly mineral; abandoned.
Brookfield	Linn	451		30	−200	
Brunswick [2]	Chariton	1,505	6-4	7	Flows.	Mineral water.
Chillicothe	Livingston	700				No water.
Do	do	539		Many.	−90	
Do	do	481		2	Flows.	
Clayton	St. Louis	1,060				
Clinton	Henry	650	8	200	+20	
Do	do	850	8	175	+20	
Do	do	900	10	400	+20	
Do	do	900	6	125	+20	
Do. [3]	do	800	8-5¼	400	+10	Water also at 310 and 425 feet.
Do. [4]	do	913		2,700		Temp. 64°.
Concordia	Lafayette	+200				In progress.
Diamond	Newton					
Eldorado Springs	Cedar	1,400	8		−28	Sulphur water.
Epworth	Shelby	410		1	−80	
Farmington (near)	St. Francois	442,650	2¼			Prospect borings for lead.
Fulton	Calloway	750	8	30	−70	
Galbraith Spring [5]	McDonald	804		Many.		
Granby (sec. 6)	Newton	876	8	600	−40	
Higginsville	Lafayette	1,512	12-5	30	−80	
Jackson	Cape Girardeau.	531	4¼	Many.	−3	Sulphur water; not in use.
Jefferson City	Cole	1,365				
Joplin		1,375	6	30	−80	Ferruginous water.
Kansas City [6]	Jackson	1,000-425			−30	Several test borings for gas. Water from 380-390 feet, 590 feet, and 995 feet. Brackish and sulphur water.
Lagrange [7]	Lewis	840		60		Brackish.
Lamar	Barton	1,000	6	Many.	−150	Good water. Abandoned.
Do	do	+2,000				
Lanahan	McDonald	1,428	6	50	Flows.	Sulphur water.
Lebanon [8]	Laclede	1,002	8	1	−200	Water at 135 and 750 feet.
Do	do	453	6¼	35		Water at 380 and 420 feet.
Lisle	Jackson	405				No water.
Lonetree		1,000				
Louisiana [9]	Pike	1,275		Many.	Flows.	Temp. 64.2°.
Mexico	Audrain	588	8	10	−100	
Do	do	1,125	8	70		
Do	do	1,100	5¼		80	
Do	do	±1,800				For oil or gas, unsuccessful. Salt water.
Mine Lamotte	Madison	670	2	4	Flows.	
Moberly		510	8	300	200?	Two wells.
Montgomery City	Montgomery	1,500	10-5¼		−30	
Do	do	600	6	70		Temp. 58°.
Mountainview	Howell	645	6		−509	
Nevada	Vernon	860	10	560	−80	
Do	do	1,001	8	700	−80	Flows to +9 feet when not pumped.

[1] Analysis, Mo. Geol. Surv., vol. 3, p. 71.
[2] Analysis, Ibid., pp. 96-97.
[3] Analysis, Mo. Geol. Surv. Reports, vol. 3, pp. 85-87, 118-119.
[4] Analysis, Ibid., pp. 120-121.
[5] Analysis, Mo. Geol. Surv. Reports, vol. 3, pp. 117-118.
[6] Analysis, U. S. Geol. Surv., 17th report, 1895-96, part 2, p. 827.
[7] Analysis, Mo. Geol. Surv. Reports, vol. 3, pp. 141-143.
[8] Record, Geology of Missouri, by Broadhead, part 2, p. 86.
[9] Record and analysis, Ibid., pp. 94-95.

MISSOURI—Continued.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Nevada[1]	Vernon	800		165	Flows.	
Oakdale	Shelby	+400				
Osceola	St. Clair	500	7¼		−20	Several water horizons.
Philadelphia	Marion	470,558		300	−6	Two wells; much water; little oil.
Poplarbluff	Butler	600	8–6		−10	
Potosi	Washington	522–585	2		−66	Three wells.
Do	do	414			−2	
Racine (4 miles north)	Newton	1,244	9		−80	
Randolph Springs[2]	Randolph	960	4	120	Flows.	Temp. 58°; mineral water.
Rockport	Atchison	678	8–6		−16	Prospect hole for coal; water at 143 feet.
St. Charles	St. Charles	1,276	6	40	−40	
St. Charles (2 miles west).	do	1,365				
Ste. Genevieve	Ste. Genevieve.	700–800				For oil or gas; unsuccessful.
St. Joseph	Buchanan	1,000	6			Prospect for coal.
Do	do	1,300	6			Do.
Do	do	1,805	6			Temp. 82°; water mineral.
St. Joseph (5 miles east).	do	500	6	Few.		
St. Louis	St. Louis	400–700		30	−200	Many wells.
St. Louis (asylum)	do	3,843¼		Few.		Temp. 105°; salty water.
St. Louis (Belcher)[3]	do	2,176		1		3 per cent salt at 1,231 feet; temp. 66°.
Do.[4]	do	2,199	9–3¼	75	Flows.	Temp. 73.4°; water from 1,515 feet.
Do.[5]	do	+1,590	6–3¼			Gas at 466 feet; salt water at 520 feet; temp. 69° at 1,351 feet.
St. Louis (power house).	do	1,474			−70	
Near Chain of Rocks	do	735	6	70	−45	Water slightly sulphurous.
Sedalia (2 miles south).	Pettis	1,500	9–6			Prospect hole; full of water.
Springfield	Greene	755	6	750		Water at 610–620 feet.
Steen Prairie	Maries					
Sullivan (5 miles south).	Crawford	1,200			To surface.	Water also at 20, 240, and 800 feet.
Topsy	Mercer	+400				
Truesdail	Warren	+400				
Unionville	Putnam	700				Some water at 215 feet; abandoned.
Warrenton	Warren	450	6–4	1	150	Three wells.
Webb City	Jasper	500	7¼		−20	Several water horizons.
Westplains	Howell	575	10	100	−40	
Winona	Shannon	700	8, 4–3	Many.	−400	Two wells.
Wright City	Warren	406	6		−70	Fine water.

PRINCIPAL PUBLICATIONS RELATING TO DEEP BORINGS IN MISSOURI.

Report on the Mineral Waters of Missouri, by Paul Schweitzer, Missouri Geological Survey, 1890–1892, Vol. III, 256 pages. Jefferson City, 1892.

[1] Analysis, Mo. Geol. Surv. Reports, vol. 3, pp. 121–122.
[2] Analysis, Ibid., pp. 73–74.
[3] Analysis, Mo. Geol. Surv. Reports, vol. 3, pp. 79–81.
[4] Analysis and record, St. Louis Acad. Science, Trans., vol. 1, pp. 80–86, pl. 5.
[5] Record, Am. Jour. Science, 2d series, vol. 15, pp. 460–461.

MONTANA.

Location.	County.	Depth.	Diameter.	Yield per minute.	Height of water.	Remarks.
		Feet.	*Inches.*	*Gallons.*	*Feet.*	
Billings	Yellowstone	1,000				All in shale.
Bozeman	Gallatin	600				Bored for oil; unsuccessful.
Chinook[1]	Choteau	956			−50	Waters also at 112, 220, 540, and 620 feet.
Fort Assiniboine	do	1,950				Small flow of gas; no water below 65 feet; all clay.
Fort Keogh	Custer	811		15	Flows.	
Glendive (courthouse).	Montana	500				Unsuccessful.
Helena	Lewis and Clarke.	1,002				
Do	do	1,023				Good flow; abandoned.
Do	do	900			−100	
Junction	Yellowstone	500			Flows.	Small flow also at 144 feet.
Miles City	Custer	472	4-2½		Flows.	
Do	do	481	4-2½		Flows.	
Do	do	456	4-2½		Flows.	
Miles City (courthouse).	do	509	4-2½		Flows.	
Miles City[2]	do	456		5	+16	Temp. 57°.
Do	do	535	4	2		
Miles City (35 miles west).	do	420	4-2½		Flows.	
Miles City	do	452-514			Flow.	5 wells.
Do	do	479	9-2½		Flow.	
Miles City (10 miles east).	do	553			Flows.	
Miles City (Reform School).	do	507			Flows.	
Rosebud	do	485-502	4-2½		Flows.	3 wells.

[1] Report on Irrigation, 52d Cong., 1st sess., Senate Ex. Doc. 41, part 2, pp. 72-73. Washington, 1893.
[2] Record, Report on Irrigation, 52d Cong., 1st sess., Senate Ex. Doc. No. 41, part 2, pp. 73, 86. Washington, 1893.

[Continued in Water-Supply Paper No. 61.]

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